EPA-APPROVED
TOTAL MAXIMUM DAILY LOADS
FOR THE
UPPER RIO PUERCO WATERSHED

June 16, 2016

Prepared by

New Mexico Environment Department, Surface Water Quality Bureau

Monitoring, Assessments, and Standards Section

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~or~

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Cover Photo:

upper Rio Puerco at Highway 550 bridge, SWQB, July 23 2015

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4Q3	4-Day, 3-year low-flow frequency
Act	New Mexico Water Quality Act
ADB	Assessment database
AU	Assessment unit
BLM	Bureau of Land Management
BMP	Best management practices
CFR	Code of Federal Regulations
cfs	Cubic feet per second
cfu	Colony forming units
CGP	Construction general stormwater permit
CWA	Clean Water Act
CWAL	Cold Water Aquatic Life
^{o}C	Degrees Celsius
EQIP	Environmental Quality Incentive Program
^{o}F	Degrees Fahrenheit
GIS	Geographic information system
HQCWAL	High Quality Cold Water Aquatic Life
HUC	Hydrologic unit code
ISC	Interstate Stream Commission
km^2	Square kilometers
LA	Load allocation
lbs/day	Pounds per day
MASS	Monitoring, Assessment and Standards Section
MGD	Million gallons per day
mg/L	Milligrams per Liter
mi^2	Square miles
mL	Milliliters
MOS	Margin of safety
MOU	Memorandum of Understanding
MS4	Municipal separate storm sewer system
MSGP	Multi-sector general stormwater permit
µS	Microsiemen
NM	New Mexico
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint source
NTU	Nephelometric turbidity units
QAPP	Quality Assurance Project Plan
RFP	Request for proposal
§	Section
SEV	Severity of ill effect
sMS4	Small Municipal Separate Storm Sewer
SWPPP	Stormwater pollution prevention plan
SWQB	Surface Water Quality Bureau
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
UAA	Use Attainability Analysis
ug/L	Micrograms per Liter

USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
USNPS	U.S. National Park Service
WBP	Watershed-based plan
WLA	Waste load allocation
WQCC	Water Quality Control Commission
WQS	Water quality standards (NMAC 20.6.4 as amended through June 5, 2013)
WQX	Water quality exchange
WRAS	Watershed restoration action strategies
wt %	Weight percent
WWTP	Wastewater treatment plant

EXECUTIVE SUMMARY

Section 303(d) of the Federal Water Pollution Control Act , a.k.a., Clean Water Act (CWA), 33 U.S.C. §1313[1], requires states to develop Total Maximum Daily Load (TMDL) management plans for water bodies determined to be impaired. A TMDL defines the amount of a pollutant that a waterbody can assimilate without exceeding the state's water quality standard for that waterbody and allocates loads to known point sources and nonpoint sources. It further identifies potential methods, actions, or limitations that could be implemented to achieve water quality standards. "Total Maximum Daily Load" is defined as the sum of the individual Waste Load Allocations ("WLA") for point sources and Load Allocations (LA) for nonpoint source and background conditions; see 40 C.F.R. §130.2(i)[2]. TMDLs also include a Margin of Safety ("MOS"), a required component that acknowledges and counteracts uncertainty.

The New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB) conducted water quality surveys of the Rio Puerco watershed of northwest New Mexico in 2011. Water quality monitoring stations were located within the watersheds to evaluate ambient water quality conditions and the impact of tributary streams. As a result of assessing data generated during these monitoring efforts, the following impairments[3] of water quality standards were found:

- Total aluminum in La Jara Creek and Nacimiento Creek;
- Uranium in Nacimiento Creek;
- Turbidity in Nacimiento Creek; and,
- Sedimentation in Rio Puerco.

This TMDL addresses the above impairments as summarized in Tables ES-1 – ES-3. The 2011 field study identified other potential water quality impairments that are not addressed in this document due to additional data needs, assessment protocol revisions or re-application, or impending use attainability analyses. If additional impairments are verified or found, subsequent TMDLs will be developed for those impairments. The SWQB has previously prepared TMDLs for portions of this watershed including: TMDLs for chronic aluminum on La Jara Creek (2007); TMDLs for sedimentation, and chronic aluminum and plant nutrients on the Rio Puerco (2007).

Under the current Draft Prioritization Framework Strategy, the SWQB's Monitoring, Assessment, and Standards Section (MASS) is next scheduled to collect water quality data in the Rio Puerco watershed in 2019 and 2020. TMDLs will be re-examined and potentially revised at those times as this document is considered to be an evolving management plan. In the event that the new data indicate that the targets used in the analyses are not appropriate and/or if new standards are adopted, the TMDLs will be adjusted accordingly. When attainment of applicable water quality

[1] http://www.epw.senate.gov/water.pdf
[2] http://www.gpo.gov/fdsys/pkg/CFR-2002-title40-vol18/pdf/CFR-2002-title40-vol18-part130.pdf
[3] http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/overview.cfm

standards has been achieved, the impairment will be removed from New Mexico's CWA §303(d) List of Impaired Waters (§303(d) List).

SWQB's Watershed Protection Section will continue to work with watershed groups to develop Watershed-Based Plans (WBPs) to implement strategies that attempt to correct the water quality impairments detailed in this document. Implementation of items detailed in the WBP will be done with participation of all interested and affected parties. Further information on WBPs is in Section 11.

ES-1 Summary for La Jara Creek (Perennial reaches above Arroyo San Jose)

New Mexico Standards Segment	20.6.4.109
Waterbody Identifier	NM-2107.A_46
Segment Length	9.86 miles
Parameters of Concern	Total aluminum
Uses Affected	Coldwater Aquatic Life
Geographic Location	Rio Puerco USGS Hydrologic Unit Code 13020204
Scope/size of Watershed	5.17 sq mi
Land Type	Southern Rockies (Ecoregion 21b, 21c, 21d and 21f)
Probable Sources	See Table 4.9
IR Category	5/5A
Priority Ranking	High
TMDL for:	**WLA_{TOTAL} + LA + MOS = TMDL**
Total aluminum, chronic	**0 + 3.90 + 0.98 = 4.88 lb/day**
Total aluminum, acute	**0 + 9.74 + 2.43 = 12.17 lb/day**

ES-2 Summary for Nacimiento Creek (Perennial part Hwy 126 to San Gregorio reservoir)

New Mexico Standards Segment	20.6.4.109
Waterbody Identifier	NM-2107.A_42
Segment Length	6.77 miles
Parameters of Concern	Turbidity, Total aluminum, Uranium
Uses Affected	Coldwater Aquatic Life, Domestic Water Source
Geographic Location	Rio Puerco USGS Hydrologic Unit Code 13020204
Scope/size of Watershed	7.62 sq mi
Land Type	Arizona/New Mexico Plateau (Ecoregion 22n), Southern Rockies (Ecosystem 21c and 21d)
Probable Sources	See Tables 4.8, 5.7 and 6.7
IR Category	5/5A
Priority Ranking	High
TMDL for:	**WLA_{TOTAL} + LA + MOS = TMDL**
Total aluminum, chronic	**0 + 2.98 + 0.75 = 3.73 lbs/day**
Total aluminum, acute	**0 + 7.46 + 1.87 = 9.33 lb/day**
Uranium	**0 + 45.1×10^{-3} + 7.95×10^{-3} = 53×10^{-3} lbs/day**

Turbidity

Duration (consecutive hrs)	WLA (lbs/day)	TMDL (lbs/day)	MOS (15%) (lbs/day)	LA (lbs/day)
720	0.00	23.56	3.53	20.03
336	0.00	25.78	3.87	21.91
168	0.00	28.30	4.25	24.06
144	0.00	28.97	4.35	24.62
120	0.00	29.63	4.44	25.19
96	0.00	31.87	4.78	27.09
72	0.00	34.25	5.14	29.11

ES-3 Summary for Rio Puerco (Perennial part northern bnd Cuba to headwaters)

New Mexico Standards Segment	20.6.4.109
Waterbody Identifier	NM-2107.A_44
Segment Length	14.48 mi
Parameters of Concern	sedimentation
Uses Affected	Coldwater Aquatic Life
Geographic Location	Rio Puerco USGS Hydrologic Unit Code 13020204
Scope/size of Watershed	17.89 sq mi
Land Type	Arizona/New Mexico Plateau (Ecoregion 22n), Southern Rockies (Ecosystem 21b, 21c, 21d and 21f)
Probable Sources	See Table 7.9
IR Category	5/5B
Priority Ranking	High
TMDL for: Sedimentation	**WLA_{TOTAL} + LA + MOS = TMDL** **0 + 75.3 + 13.3 = 88.6 lbs/day**

1.0 INTRODUCTION

Under Section (§) 303 of the CWA, individual states establish water quality standards, which are subject to the approval of the U.S. Environmental Protection Agency (USEPA). Under §303(d)(1) of the CWA (Water Quality Standards and Implementation Plans), states are required to develop a list of waters within a state that are impaired and establish a TMDL for each pollutant. A TMDL is defined as "*a written plan and analysis established to ensure that a waterbody will attain and maintain water quality standard including consideration of existing pollutant loads and reasonably foreseeable increases in pollutant loads* (USEPA, 1999)." A TMDL documents the amount of a pollutant a waterbody can assimilate without violating a state's water quality standard. It also allocates that load capacity to known point sources and nonpoint sources (NPS) at a given flow. TMDLs are defined in the Code of Federal Regulations (Water Quality Planning and Management, 1985) as the sum of the individual Waste Load Allocations (WLA) for point sources and Load Allocations (LA) for NPS and natural background conditions, and include a margin of safety (MOS). This document provides TMDLs for assessment units (AUs) within the Rio Puerco Basin that have been determined to be impaired based on a comparison of measured concentrations and conditions with water quality criteria.

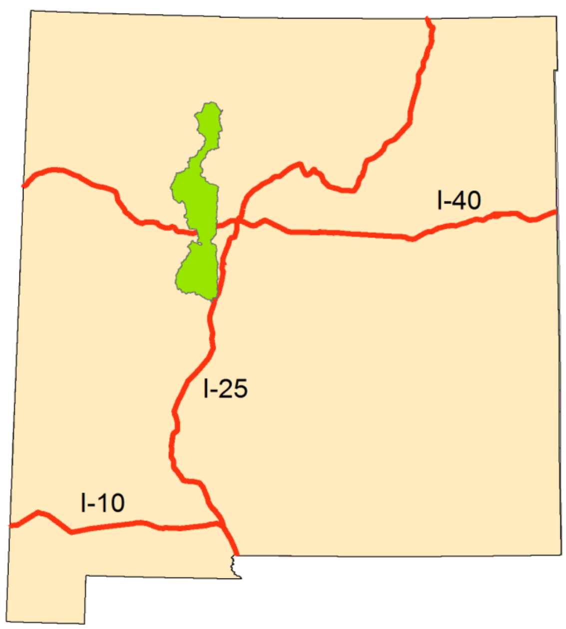


Figure 1.1 Location of the Rio Puerco watershed in New Mexico.

This document is divided into several sections. Section 2.0 provides background information on the Rio Puerco Basin. Section 3.0 provides additional watershed information and information on the water quality surveys performed in the basin in 2011. Section 5.0 presents TMDLs developed for total recoverable aluminum; Section 6.0 presents a TMDL developed for uranium; Section 7.0 presents a TMDL for turbidity; and Section 8.0 presents a TMDL developed for sedimentation. Pursuant to CWA §106(e)(1), Section 9.0 provides a monitoring plan in which methods, systems, and procedures for data collection and analysis are discussed. Section 10.0 discusses implementation of TMDLs and the relationship between TMDLs and Watershed Based Plans (WBPs); Section 11.0 discusses assurance; Section 12.0 discusses public participation in the TMDL process; and Section 13.0 provides references for this document. Appendices are referenced throughout and are found at the end of the document.

2.0 BASIN BACKGROUND

2.1 Watershed Characteristics

The Rio Puerco HUC 8 watershed is located along the east-southeast margin of the Colorado Plateau, along a transition zone with the Rio Grande Rift. Friable or poorly indurated Mesozoic, upper Paleozoic, and lower Cenozoic sedimentary strata dominate the geologic setting of the area. Units include Permian through Tertiary age continental and marine sandstones, shales, mudstones, and carbonate rocks. These strata are generally flat lying, often faulted, and carved into broad valleys flanked by mesas and mountains. The mountainous areas along the margins of the northeast and west-central watershed are made up of intrusive igneous rocks (granitic plutonic rocks) and metamorphic rocks (gneiss and schist). Younger Tertiary or Quaternary volcanic rocks intrude the sediments and occasionally cap high standing mesas. Tertiary and Quaternary valley fill, pediment gravels, talus, and alluvial deposits mantle the geologic section (Coleman et al., 1998).

The main stem of the Rio Puerco begins in a wetland in Omernik Ecoregion (Omernik and Griffiths, 2008) 21b (Crystalline Subalpine Forests) in the Nacimiento Mountains east of Cuba, NM, within the San Pedro Parks Wilderness area of the Santa Fe National Forest and descends through ecoregions 21c (Crystalline Mid-Elevation Forests), 22n (Near-Rockies Valleys and Mesas), 22i (San Juan-Chaco Table Lands), 22j (Semiarid Tablelands), and joins the Rio Grande in 22m (Albuquerque Basin). Assessment Units addressed by TMDLs in this document are located above Cuba, where the Rio Puerco headwaters come out of the Santa Fe National Forest on the west side of the Jemez Mountains.

A high regional surface gradient and an excess of straight drainage channel segments combines with the region’s climatic setting and vulnerable sedimentary lithologies to create the watershed’s dramatic erosion (Gellis, 2000). Average rainfall in the basin varies annually between 30.5 and 51 cm, delivered mostly by late summer monsoon thunderstorms that create violent flash flooding that sweeps out of well- vegetated highlands across sparsely vegetated slopes and valley surfaces, carrying away thin topsoil and weathered bedrock (Gellis, 2000).

The reach of the Rio Puerco downstream of Cuba flows through a complex mixture of private, State, and Federal lands in a wide, deeply incised, vertical-walled canyon with banks up to 10 m high. Erosional processes within this reach of the stream are extensive. Significant landscape erosion and channel incision are common throughout the majority of the Rio Puerco Watershed (Coleman et al., 1998). The basin is one of the nation's most actively eroding watersheds. The Rio Puerco Basin has been documented to transport one of the highest known average annual sediment loads and is the major source of suspended sediment

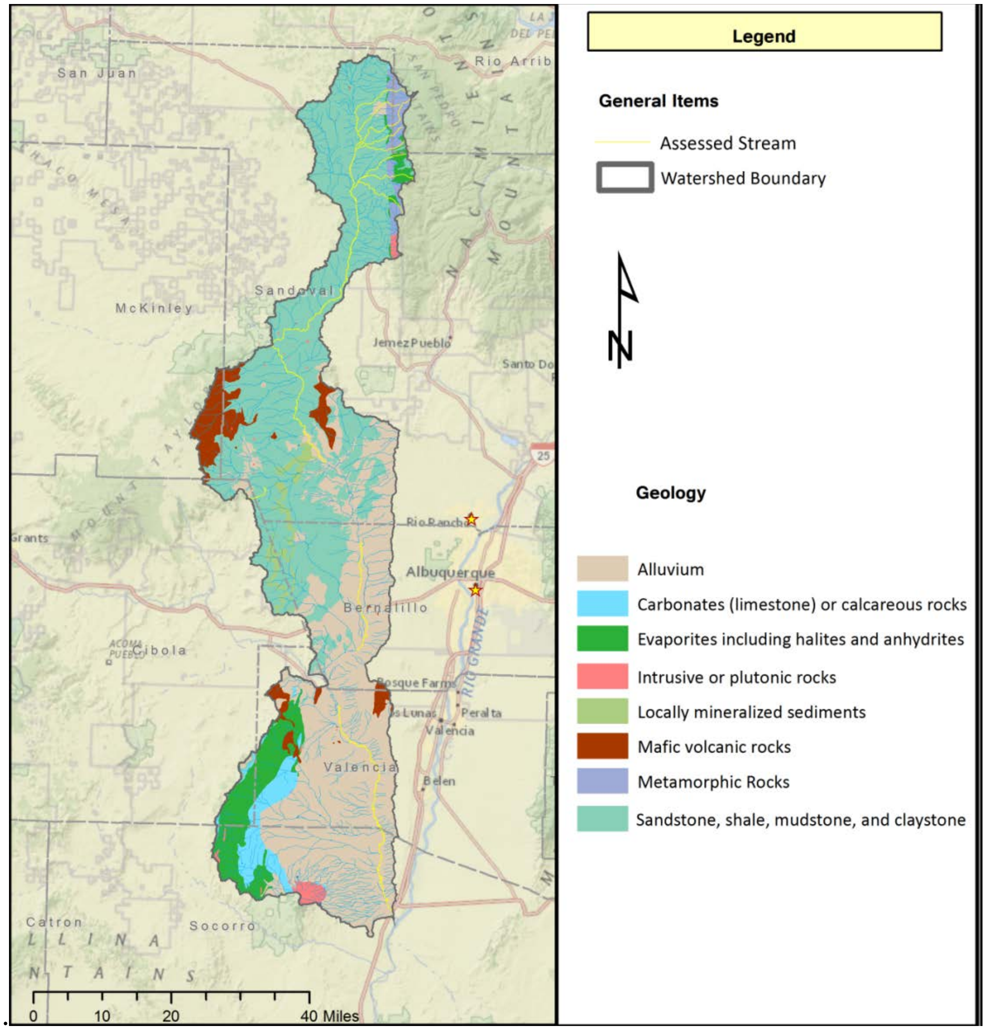


Figure 2.1 Geology of the Rio Puerco watershed

entering the Rio Grande above Elephant Butte Reservoir (Happ, 1948). Satellite images show that many parts of the basin are very responsive to seasonal variations in precipitation, whereas scattered riparian corridors in main stem and tributary drainages are increasingly stable and less prone to significant vegetation changes in response to variation in precipitation.

From the Santa Fe National Forest boundary downstream approximately 10 kilometers (km) to the Village of Cuba, domestic and wildlife grazing, road construction, and maintenance activities on private and public lands have impacted riparian vegetation and initiated discontinuous stream channel incision. In some local segments the stream bed is now 1.5 to 3 m below its original floodplain, whereas adjacent reaches remain relatively stable. At and below the Village of Cuba, flows from several tributaries coalesce and drop off the western face of the Sierra Nacimiento. This flow combines with effluent from the Cuba wastewater treatment plant (WWTP) to provide perennial flow in the Rio Puerco downstream toward the confluence with Arroyo Chijuilla (Coleman et al., 1998).

> The foothills north and northeast of Cuba are composed of erodible sedimentary units (clay and mudstones), so while stream incision occurs in this drainage system very close to its headwaters area, the downstream reach's sand-dominated setting and decreased gradient allows for more stable channel dimension, pattern, and profile. The least incised, best vegetated, and most stable segment occurs 1.6 to 4.8 km (1-3 miles) upstream of the Village of Cuba, below which deep incision and a broad meandering pattern becomes characteristic across the wide flat valleys to the distant confluence with the Rio Grande (Coleman et al., 1998).

Appendix A is a list of special status wildlife species that are known to occur in Sandoval County associated with riparian or aquatic habitats. Because much of the affected AUs are on the Santa Fe National Forest, US Forest Service sensitive species, as well as state and federal listed and sensitive species, have been included. The list was generated using the Biota Information System of New Mexico. Not all of the species listed for Sandoval County necessarily occur in the specific watersheds covered by TMDLs in this report.

2.2 Water Quality Standards and Designated Uses

Water quality standards (WQS) for all assessment units in this document are set forth in sections 20.6.4.99 and 20.6.4.109 of the *Standards for Interstate and Intrastate Surface Waters*, 20.6.4 New Mexico Administrative Code (NMAC), as amended through February 14, 2013 (NMAC, 2013). These standards have been approved by USEPA for CWA purposes. The following is the relevant NMAC section:

20.6.4.109 RIO GRANDE BASIN - Perennial reaches of Bluewater creek excluding Bluewater lake and waters on tribal lands, Rio Moquino upstream of Laguna pueblo, Seboyeta creek, Rio Paguate upstream of Laguna pueblo, the Rio Puerco upstream of the northern boundary of Cuba, and all other perennial reaches of tributaries to the Rio Puerco, including the Rio San Jose in Cibola county from the USGS gaging station at Correo upstream to Horace springs excluding waters on tribal lands.

A. Designated Uses: coldwater aquatic life, domestic water supply, fish culture, irrigation, livestock watering, wildlife habitat and primary contact; and public water supply on La Jara creek.

B. Criteria: the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criteria apply: phosphorus (unfiltered sample) 0.1 mg/L or less; the monthly geometric mean of *E. coli* bacteria 126 cfu/100 mL or less, single sample 235 cfu/100 mL or less.

[20.6.4.109 NMAC - Rp 20 NMAC 6.1.2107, 10-12-00; A, 05-23-05; A, 12-01-10; A, 07-10-12]
[**NOTE:** The standards for Bluewater lake are in 20.6.4.135 NMAC, effective 07-10-12]

NM's *Standards for Interstate and Intrastate Surface Waters* (NMAC, 2013) establish surface water quality standards that consist of designated uses of surface waters of the State, the water quality criteria necessary to protect the uses, and an antidegradation policy. NM's antidegradation policy, which is based on the requirements of 40 CFR Part 131.12 (Establishment of Water Quality Standards), describes how waters are to be protected from degradation (Subsection A of 20.6.4.8 NMAC) while the *Antidegradation Policy Implementation Procedures* establish the process for implementing the antidegradation policy. At a minimum, the policy mandates that "the level of water quality necessary to protect the existing uses shall be maintained and protected in all surface waters of the state." In addition, whether or not a segment is impaired, the State's antidegradation policy requirements, as detailed in the *Antidegradation Policy Implementation Procedures* must be met. TMDLs are consistent with the policy because implementation of a TMDL restores water quality so that existing uses are protected and water quality criteria are achieved. The *Antidegradation Policy Implementation Procedure* can be found in Appendix A of the *Statewide Water Quality Management Plan and Continuing Planning Process* document (NMED/SWQB, 2011a).

3.0 RIO PUERCO WATERSHED (HUC 13020204)

3.1 Water Quality Survey

SWQB intensively surveyed the Rio Puerco basin in 2011 (NMED/SWQB, 2014). Surface water quality samples were collected monthly between March and November for the 2011 SWQB field survey. Surface water quality monitoring stations were selected to characterize water quality of stream reaches, termed Assessment Units, throughout the basin. Stations in the study are shown on Figure 3.1. Stations were located so as to evaluate the impact of tributary streams and to determine ambient water quality conditions. Sampling procedures followed the SWQB standard operating procedures (NMED/SWQB, 2011). Surface water grab sample from these stations were analyzed for a variety of chemical and physical parameters. Data from grab samples are housed in the SWQB Surface Water Quality Information Database (SQUID) and uploaded to USEPA's Water Quality Exchange (WQX) database.

3.2 Hydrologic Conditions

There is one active United States Geological Survey (USGS) gaging station within the watersheds in this document. USGS 08332525 – Rio Puerco at Cuba, NM - is located on the Rio Puerco at the south end of Cuba, with a period of record ranging from 1960 to the present. This is a Crest Stage Gage which is used only to collect annual peak flow information, and hence does not provide much useful data for the purpose of the TMDL. The peak flow in 2011 was approximately 1800 cfs.

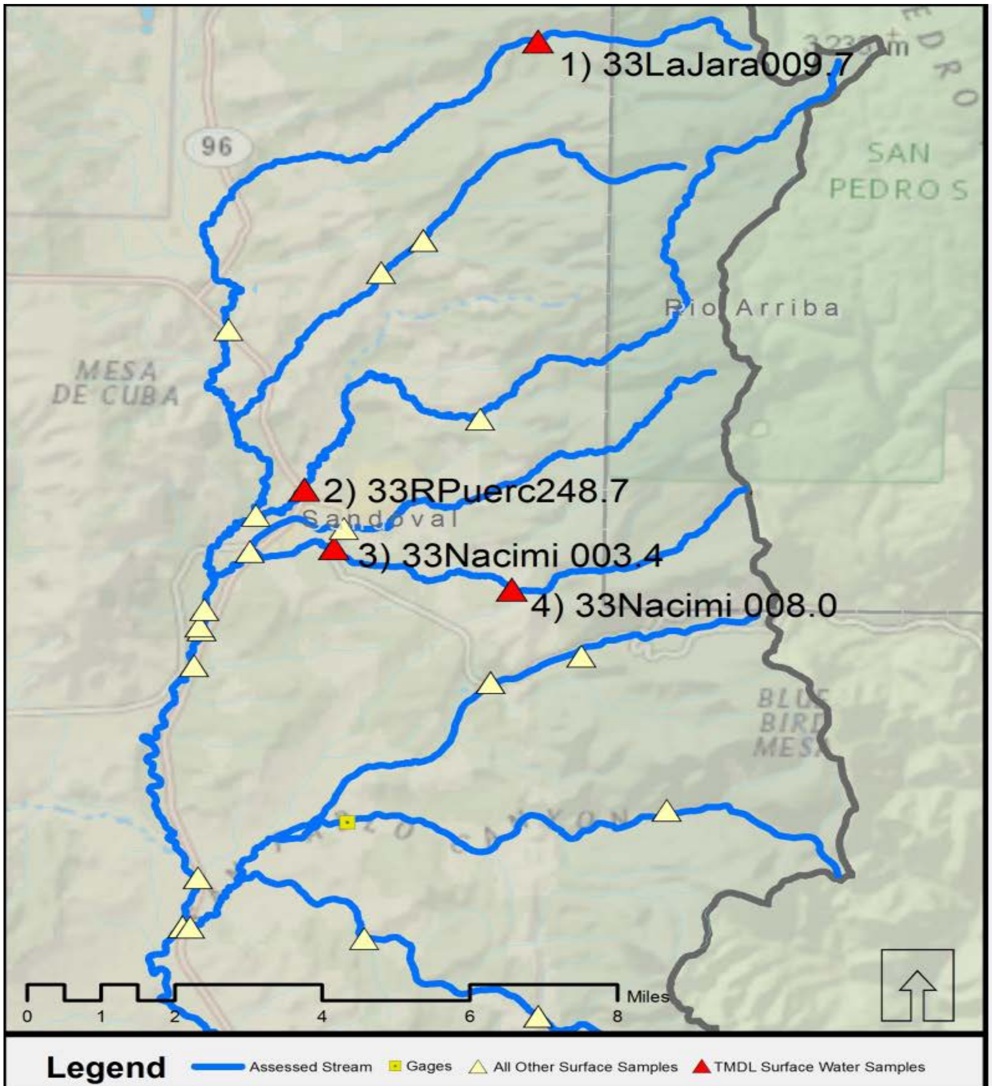
As stated in the SWQB Assessment Protocol (NMED/SWQB, 2013), data collected during all flow conditions, including low flow (i.e., flows below the 4Q3), were used to determine designated use attainment status during the assessment process. The 4Q3 is the annual lowest four (4) consecutive day flow that occurs with a frequency of at least once every three (3) years. In terms of assessing designated use attainment in ambient surface waters, WQS apply at all times under all flow conditions.

3.3 Land Use and Impairments

TMDLs have been developed for assessment units in which constituent or pollutant concentrations measured during the 2011 water quality survey, as combined with data from outside sources that meet NMED's data quality requirements, indicate impairment. Because watershed land use and land ownership provide insight into probable sources of impairment, they are presented in this section for the Rio Puerco Basin (Figure 3.2). In addition, impairments included in the 2014-2016 CWA §303(d) List (NMED/SWQB, 2014a) within the watersheds are discussed below.

3.4 Watershed Characteristics

The Rio Puerco watershed occurs mostly in Sandoval and Bernalillo Counties, with small portions in Rio Arriba, McKinley, Cibola and Valencia Counties. As presented in Figure 3.2, land ownership or management in this watershed is 43% private, 23% Tribal, 20% BLM, 6% State, 6% USFS, and 1% each State Game & Fish and US Fish & Wildlife Service. Land uses are 58% rangeland, 40% forest, and <1% each agricultural and urban or built-up. However the upper reaches of the watershed, covered by this TMDL report, are dominated by forest, with a significant amount of rangeland as well. Approximately the upper half of each of the AU reaches addressed in this TMDL report are within the boundaries of the Jemez Ranger District of the Santa Fe National Forest, and the rest is on private land ownership.



Number	Assessment Unit	Station ID	Station Name
1	La Jara Creek (Perennial reaches abv Arroyo San Jose)	33LaJara009.7	La Jara Creek abv irrigation diversion
2	Rio Puerco (Perennial prt northern bnd Cuba to headwaters)	33RPuerc248.7	Rio Puerco at Hwy 550 bridge
3	Nacimiento Creek (Perennial part Hwy 126 to San Gregorio Rsvr)	33Nacimi 003.4	Nacimiento Creek at Hwy 126
4	Nacimiento Creek (Perennial part Hwy 126 to San Gregorio Rsvr)	33Nacimi 008.0	Nacimiento Creek at Eureka Rd.

Figure 3.1 Monitoring locations in the upper Rio Puerco. Red triangles are those stations on which TMDLs in this report are based. Yellow triangles indicate all other sampling stations.

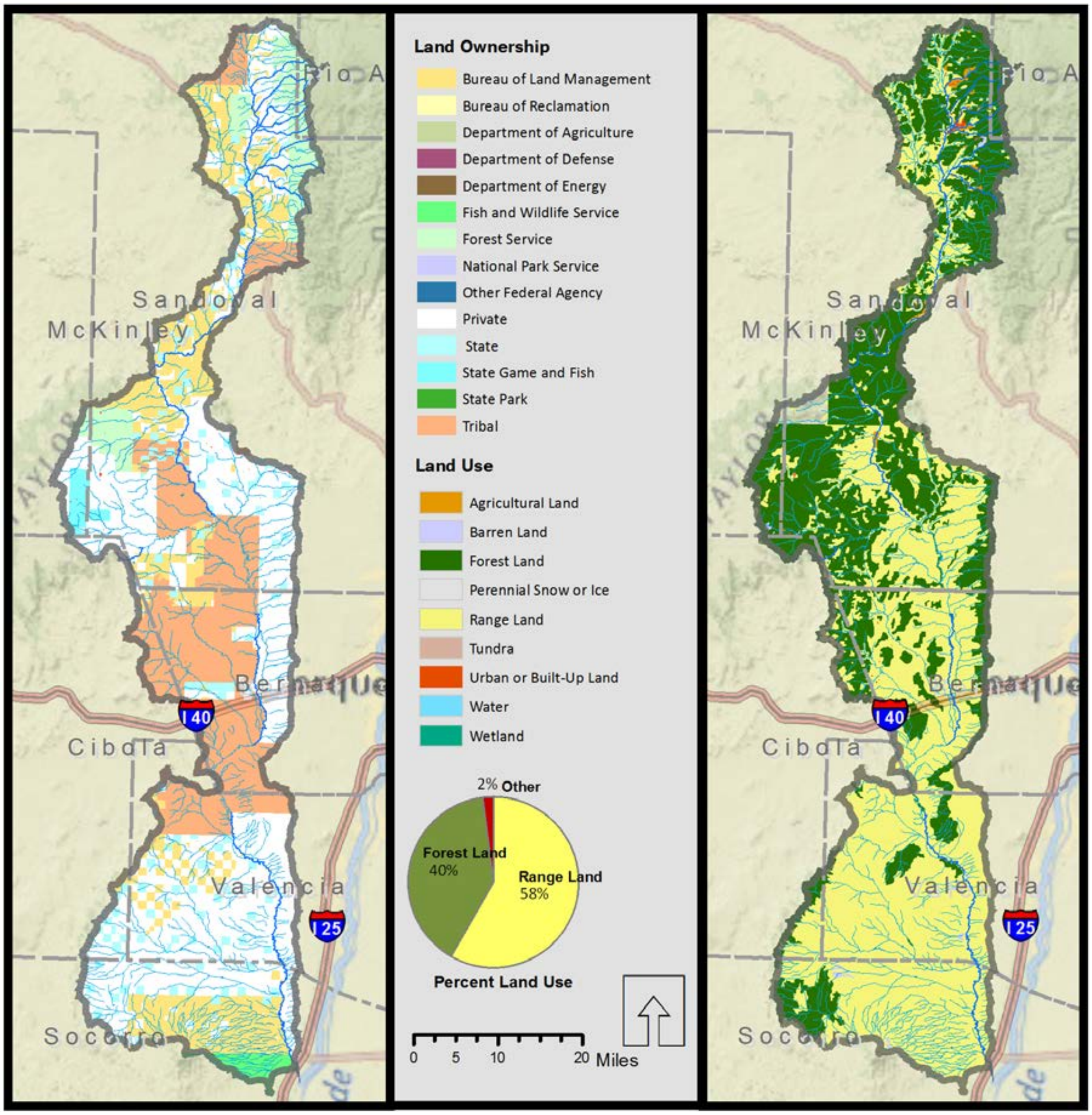


Figure 3.2 Land ownership (left) and land use in the Rio Puerco watershed

Waterbodies in the Rio Puerco watershed were included in the 2014-2016 CWA §303(d) List for aluminum, turbidity, sedimentation, nutrients, ammonia, E. coli, and mercury. The following TMDLs are presented in this document for the Rio Puerco watershed:

- La Jara Creek (Perennial reaches above Arroyo San Jose) : total aluminum
- Nacimientio Creek (Perennial part Hwy 126 to San Gregorio Reservoir): total aluminum, uranium, turbidity
- Rio Puerco (Perennial part northern boundary Cuba to headwaters): sedimentation

3.5 Wildfire

No large fires have occurred in the watershed of the Upper Rio Puerco TMDL Assessment Units since 2000.

4.0 ALUMINUM

Chronic high levels of Al can be toxic to fish, benthic invertebrates, and some single-celled plants. Aluminum concentrations from 0.1 to 0.3 mg/L (100 to 300 ug/L) increase mortality and retard growth, gonadal development, and egg production of fish. Information on the toxic forms of Al in natural waters suggest that soluble trivalent Al (Al^{3+}) exerts a toxic effect on fish by binding to the negative charge of gill tissues, thereby disrupting ionoregulatory and respiratory balance (Exley et al., 1991; Gensemer and Playle, 1999). This charge interaction is complicated by subsequent polymerization of insoluble, positive-charged Al oxyhydroxides to fish gill tissues and thus both soluble and insoluble forms are implicated in the toxic response of fish to Al (Gensemer and Playle, 1999).

In 2010, the NM Water Quality Control Commission approved a change of the standard from dissolved Al to hardness-dependent total recoverable Al. In 2012, EPA approved the change for use in waters where the pH is between 6.5 and 9. Waters of La Jara and Nacimiento Creeks were within the applicable pH range during all of the 2011 sampling events. The term “total recoverable” refers to the analytical method used in laboratory analysis, and is essentially interchangeable with the term “total”. “Total recoverable” is used here to reflect the language in 20.6.4.900.I NMAC, specifically, “For aluminum, the criteria are based on analysis of total recoverable aluminum in a sample that is filtered to minimize the mineral phase as specified by the department.” Based on recommendations from an aluminum filtration study conducted by SWQB staff (NMED/SWQB, 2012a), if the turbidity exceeds 30 NTU, samples that will be analyzed for total recoverable Al are filtered using a filter of 10 μm pore size that minimizes mineral-phase aluminum without restricting amorphous or colloidal phases.

4.1 Monitoring Results

To meet aquatic life designated uses, the SWQB Assessment Protocol (NMED SWQB, 2013) says that for any one pollutant, there shall be no more than one exceedance of the acute criterion, and no more than one exceedance of the chronic criterion in three years. Assessment of the data from the 2011 SWQB intensive water quality survey in the Rio Puerco watershed identified exceedances of the New Mexico water quality standards for total recoverable aluminum (Al) in La Jara Creek (perennial reaches above Arroyo San Jose) and Nacimiento Creek (perennial part northern boundary Cuba to headwaters). Consequently, these waterbodies were listed on the 2014-2016 CWA §303(d) List (NMED/SWQB, 2014a) for total recoverable aluminum-chronic.

The La Jara Creek AU was included on the 2006-2008 §303(d)/ §305(b) list for dissolved aluminum, based on 3 out of 7 exceedances of the chronic dissolved Al criterion. A TMDL was completed in 2007. During the 2011 survey, there were 2 out of 7 exceedances of the acute total recoverable Al standard (hence the chronic standard was also exceeded as it is lower than the acute standard), as shown on Table 4.2. Therefore, the dissolved Al impairment was changed to total recoverable Al.

During the 2011 survey, there were 3 out of 8 exceedances of the chronic total recoverable Al standard in Nacimiento Creek, two of which also exceeded the acute standard, as shown on Table 4.1. Therefore, the AU was listed for impairment due to total recoverable Al. Nacimiento Creek was not previously listed for Al.

For this TMDL document, target values for aluminum are based on the reduction in aluminum necessary to achieve the numeric criterion associated with the cold water aquatic life (CWAL) use. The New Mexico water quality standards identify chronic and acute aluminum as hardness-dependent criteria (20.6.4.900.I NMAC); their numeric criteria are based on concurrent hardness data. Using Equation 4.1 for chronic aluminum, and Equation 4.2 for acute aluminum, the numeric criteria for each sample date were calculated and are presented in Table 4.1 and 4.2. Values for the constants m and b are provided in the WQS; hardness is defined as concentration in mg/L of calcium carbonate. For aluminum the equations are valid only for dissolved hardness concentrations of 0-220 mg/L. For dissolved hardness concentrations above 220 mg/L, the aluminum criteria for 220 mg/L apply.

Equation 4.1 $exp(m_c \times [ln(hardness)] + b_c)$

Where, m_C = 1.3695

b_C = 0.9161

Equation 4.2 $exp(m_a \times [ln(hardness)] + b_a)$

Where, m_a = 1.3695

b_a = 0.1.8308

Table 4.1 Calculated hardness-dependent aluminum criteria –Nacimiento Creek

Sample Date	Hardness (mg/L CaCO3)	Calculated Acute Criterion (ug/L)	Calculated Chronic Criterion (ug/L)	Measured Aluminum Concentration (ug/L)	Measured Flow (cfs)
Nacimiento Creek at Eureka Road					
March 22, 2011	191.46	8330	3336	150	1.5[(c)]
April 13, 2011	68.5	2040	816	1480[(a)]	0.94
May 4, 2011	59.18	1670	668	2730[(b)]	6.07
June 1, 2011	59.03	1660	666	3000[(b)]	NA[(d)]
August 17, 2011	175.11	7370	2952	760	<1[(c)]
September 7, 2011	178.87	7580	3039	1010	<1[(c)]
Nacimiento Creek at Highway 126					
May 13, 2011	141.06	5480	2207	1400	3.29
June 1, 2011	220 (max)	10,070	4035	560	<1[(c)]

(a) Indicates exceedance of the calculated chronic criterion; (b) Indicates exceedance of the calculated chronic and acute criteria; (c) Flow based on a visual estimate; (d) Flow was not measured or estimated

Table 4.2 Calculated hardness-dependent aluminum criteria –La Jara Creek

Sample Date	Hardness (mg/L CaCO3)	Calculated Acute Criterion (ug/L)	Calculated Chronic Criterion (ug/L)	Measured Aluminum Concentration (ug/L)	Measured Flow (cfs)

March 22, 2011	46.1	1180	470	70	1.8
April 14, 2011	39.46	960	380	140	1.69
May 13, 2011	21.11	410	160	810[(a)]	11.12
June 1, 2011	16.54	290	120	330[(a)]	13.26
August 17, 2011	46.76	1210	480	40	1[(b)]
September 7, 2011	52.92	1430	570	50	1[(b)]
October 25, 2011	46.1	1180	470	40	1[(b)]

(a) Indicates exceedance of the calculated chronic and acute criteria; (b) Flow based on a visual estimate

4.2 Flow

TMDLs are calculated at a specific flow, and aluminum concentrations can vary as a function of flow. SWQB determined streamflow by taking direct flow measurements utilizing standard procedures or visual estimates (NMED/SWQB, 2011). All of the aluminum samples were collected at moderate flows, ranging from <1 to 13.26 cfs. Exceedences were reported at a variety of flow levels in Nacimiento Creek, and at higher flows in La Jara Creek.

According to the New Mexico Water Quality Standards (NMAC, 2013), the low flow critical condition is defined as the 4-day, 3-year low-flow frequency (4Q3, 20.6.4.11(B)(2) NMAC) for numeric criteria set in 20.6.4.97 through 20.6.4.900 NMAC, as well as Subsection F of 20.6.4.13 NMAC (aluminum criteria are defined in Subsection I, 20.6.4.900 NMAC). For this parameter, the critical flow value used to calculate the TMDLs was obtained using a 4Q3 regression model. The 4Q3 is the annual lowest four (4) consecutive day flow that occurs with a frequency of at least once every three (3) years.

Because Nacimiento and La Jara Creeks are ungaged streams, an analysis method developed by Waltemeyer (2002) was used to estimate the critical low flow. In Waltemeyer's analysis, two regression equations for estimating 4Q3 were developed based on physiographic regions of NM (i.e., statewide and mountainous regions above 7,500 ft in elevation). The average elevation of these watersheds is above 7,500 ft, so the mountainous regions regression equation was used. The following mountainous regions regression equation (Equation 4.3) is based on data from 40 gaging stations located above 7,500 ft in elevation with non-zero discharge (Waltemeyer 2002):

Equation 4.3

$$4Q3 = 7.3287 \times 10^{-5} DA^{0.70} {P_w}^{3.58} S^{1.35}$$

Where:

4Q3 = Four-day, three-year low-flow frequency (cfs)

DA = Drainage area (mi^2)
P_w = Average basin mean winter precipitation (inches)
S = Average basin slope (%)

The 4Q3 value calculated using Waltemeyer's method is presented in Table 4.3. Parameters used in the calculation were determined using Basins, a GIS application. The 4Q3 result from Equation 6.2 is in cfs. Units were converted to million gallons per day (MGD) for use in the TMDL (Equation 4.4).

It is important to remember that the TMDL itself is a value calculated at a defined critical condition as part of a planning process designed to achieve water quality standards. Since flows vary throughout the year in these systems, the actual load at any given time will vary based on the changing flow. Management of the load to improve stream water quality is the goal.

Table 4.3 Calculation of 4Q3 in Nacimiento and La Jara Creeks

Assessment Unit	Average Elevation (ft)	Drainage Area (mi^2)	Mean Winter Precipitation (in)	Average Basin Slope (percent)	4Q3 (cfs)	4Q3 (MGD)
Nacimiento Creek (Perennial part Hwy 126 to San Gregorio reservoir)	8174	7.62	13.16	0.189	0.33	0.213
La Jara Creek (Perennial reaches above Arroyo San Jose)	9913	5.17	21.35	0.285	2.44	1.58

4.3 Loading Capacity

This section describes the relationship between the numeric target and the allowable pollutant load by determining the total assimilative capacity of a waterbody, or loading capacity, for aluminum. The loading capacity is the maximum amount of pollutant that a waterbody can receive at a given flow while meeting its water quality objectives. These TMDLs were developed based on simple dilution calculations using the 4Q3 flow, the water quality criterion, and a unit conversion factor (Equation 4.3, Table 4.3). Because the water quality criterion for aluminum is hardness dependent, the average of the hardness values measured in Nacimiento and La Jara Creeks during the 2011 SWQB survey was used to calculate the numeric criteria for these TMDLs (Table 4.4). Additionally, concentration values have been converted from micrograms per liter (ug/L) to milligrams per liter in order to maintain proper unit conversion in the TMDL calculation (Appendix A).

Equation 4.4

$$Critical\ Flow\ \times WQS \times Unit\ Conversion\ Factor = Target\ Loading\ Capacity\ (TMDL)$$

Table 4.4 TMDL / target loads for aluminum in Nacimiento and La Jara Creeks

Assessment Unit	Critical Flow (MGD)	WQS Al Criterion (mg/L)	Unit Conversion Factor	Target Load (lbs/day)
Nacimiento Creek (Perennial part Hwy 126 to San Gregorio reservoir)	0.213	2.10 (chronic)	8.34	3.73
	0.213	5.25 (acute)	8.34	9.33
La Jara Creek (Perennial reaches above Arroyo San Jose)	1.58	0.37 (chronic)	8.34	4.88
	1.58	0.92 (acute)	8.34	12.12

By applying Equation 4.4 to aluminum, it is determined that Nacimiento Creek can transport approximately 3.73 lbs/day of aluminum during critical flow condition and instream concentrations will not exceed 2097 ug/L, at a hardness of 136.65 mg/L $CaCO_3$. La Jara Creek can transport approximately 4.88 lbs/day of aluminum during critical flow condition and instream concentrations will not exceed 370 ug/L, at a hardness of 38.43 mg/L $CaCO_3$.

The measured load for aluminum was calculated using concentrations found during exceedance events. In order to achieve comparability between the target and measured loads, the same flow value was used for both calculations, although measured flow was typically lower than the calculated 4Q3. The arithmetic mean of the collected data was substituted for the numeric target in Equation 4.4. The same unit conversion factor was utilized. The calculated measured load is shown in Table 4.5.

Table 4.5 Measured aluminum load in Nacimiento and La Jara Creeks

Assessment Unit	WQS	Critical Flow (MGD)	Arithmetic Mean Concentration (mg/L)	Unit Conversion Factor	Measured Load (lbs/day)
Nacimiento Creek (Perennial part Hwy 126 to San Gregorio reservoir)	Chronic	0.213	2.403	8.34	4.26
	Acute	0.213	2.865	8.34	5.09

La Jara Creek (Perennial reaches above Arroyo San Jose)	Chronic and Acute	1.58	0.570	8.34	7.51

The load reduction necessary to meet the target load was calculated to be the difference between the calculated Target Load (Table 4.4) and the measured load (Table 4.5), as shown in Table 4.6. As discussed previously, the aluminum criterion is hardness-dependent, thus the actual load reduction required will vary with hardness at any given time.

Table 4.6 Percent reduction for aluminum in Nacimiento and La Jara Creeks

Assessment Unit	WQS Type	Target Load (lbs/day)	Measured Load (lbs/day)	Load Reduction (lbs/day)	Percent Reduction (%)[(a)]
Nacimiento Creek (Perennial part Hwy 126 to San Gregorio reservoir)	chronic	3.73	4.26	0.53	12.4
	acute	9.33	5.09	*	*
La Jara Creek (Perennial reaches above Arroyo San Jose)	chronic	4.88	7.51	2.63	35.0
	acute	12.17	7.51	*	*

* Hardness values for the two exceedance events are lower than the other hardness values measured during the survey, so the hardness used to calculate the TMDL is greater than that used for the measured load. Thus the TMDL appears to be greater than the measured load despite exceedances of the WQS.

4.4 Margin of Safety and Allocations

4.4.1 Margin of Safety

TMDLs should reflect a MOS based on the uncertainty or variability in the data, the point and nonpoint source load estimates, and the modeling analysis. For this aluminum TMDL, the MOS was developed using a combination of conservative assumptions and inputs and explicit recognition of potential errors in flow calculations. Therefore, the MOS is the sum of the following assumptions:

- Conservative Assumptions:
    - Aluminum does not readily degrade in the environment.
- Explicit recognition of potential errors:
    - Uncertainty exists in sampling nonpoint sources of pollution. A conservative MOS for this element is therefore **5%**.
    - Critical flow was determined using a regression equation based on sites statewide. There is inherent error in using this equation, including uncertainty in the winter precipitation, as well as changes in precipitation patterns; a conservative MOS for this element is **10%**.

- The criterion used to develop the TMDLs is based on the average hardness measurement of the stream during the 2011 SWQB survey of La Jara and Nacimiento Creeks; a conservative MOS for this element is **5%**.

The total MOS for these TMDLs is **20%**.

4.4.2 Waste Load Allocation

There are no existing permitted point sources affecting these assessment units, nor any identified MS4 or Municipal Separate Storm Sewer (MS4) areas in the watersheds.

In contrast to discharges from other industrial stormwater and individual process wastewater permitted facilities, stormwater discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the NPDES Construction General Permit (CGP) requires preparation of a Storm Water Pollution Prevention Plan (SWPPP) that includes identification and control of all pollutants associated with the construction activities to minimize impacts to water quality. In addition, the current CGP also includes state-specific requirements to implement BMPs that are designed to prevent, to the maximum extent practicable, an increase in sediment or a parameter that addresses sediment (e.g., TSS, turbidity, siltation, stream bottom deposits) and flow during and after construction compared to pre-construction conditions. In this case, compliance with a SWPPP that meets the requirement of the CGP is generally assumed to be consistent with this TMDL.

Stormwater discharges from active industrial facilities are generally covered under the current NPDES Municipal Stormwater General Permit (MSGP). This permit also requires preparation of an SWPPP, which includes specific requirements to limit (or eliminate) pollutant loading associated with the industrial activities in order to minimize impacts to water quality. Compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL.

It is not possible to calculate individual WLAs for facilities covered by the MSGP at this time using readily available tools. The discharges from these permits are typically transitory and enforcement is complex as permittees are temporary. Loads that are in compliance with the MSGP are therefore currently included as part of the LA. While these sources are not given individual allocations, they are addressed through other means, including BMPs, stormwater pollution prevention conditions, and other requirements.

4.4.3 Load Allocation

In order to calculate the LA for aluminum, the MOS was subtracted from the target load (TMDL) using Equation 4.5:

Equation 4.5

$$LA + MOS = TMDL$$

or

$$LA = TMDL - MOS$$

Table 4.7 presents how the TMDL was allocated between nonpoint sources and the MOS.

Table 4.7 Load allocation for aluminum in Nacimiento and La Jara Creeks

Assessment Unit	TMDL (lbs/day)	MOS (20%) (lbs/day)	LA (lbs/day)
Nacimiento Creek (Perennial part Hwy 126 to San Gregorio reservoir)	3.73 (chronic)	0.75	2.98
	9.33 (acute)	1.87	7.46
La Jara Creek (Perennial reaches above Arroyo San Jose)	4.88 (chronic)	0.98	3.90
	12.17 (acute)	2.43	9.74

4.5 Identification and Description of Pollutant Sources

SWQB fieldwork includes an assessment of the probable sources of impairment. The approach for identifying probable sources of impairment includes additional input from a variety of stakeholders including landowners, watershed groups, and local, state, tribal, and federal agencies. Probable source sheets are filled out by SWQB staff during watershed surveys and watershed restoration activities. The draft probable source list was reviewed and modified as necessary with watershed group/stakeholder input during the TMDL public meeting and comment period. See a full description of the probable source documentation process, and the completed sheets for the upper Rio Puerco impaired AUs, in Appendix B.

Although this procedure includes subjective and qualitative elements, SWQB has concluded that it provides the best available information for the identification of probable sources of impairment in a watershed. The list of probable sources is not intended to single out any individual land owner or particular land management activity and generally includes several sources per impairment. Pollutant sources that may contribute to each segment were determined by field reconnaissance and evaluation (Table 4.8 and 4.9). Probable sources of aluminum impairments will be evaluated, refined, and changed as necessary through the WBP.

Table 4.8 Probable source summary for aluminum - Nacimiento Creek (Perennial part Hwy 126 to San Gregorio reservoir)

Probable Anthropogenic Sources	Probable Natural Sources
Channelization	Drought-related impacts
Dams/diversion	Recent bankfull or overbank flows
<u>Probable Anthropogenic Sources</u>	<u>Probable Natural Sources</u>
Highway/road/bridge runoff	High clay content in soils
Impervious surfaces	
Inappropriate waste disposal	

Residences/buildings
Abandoned mine tailings
Rangeland grazing
Low water crossing
Exotic species

Table 4.9 Probable source summary for aluminum - La Jara Creek (Perennial reaches above Arroyo San Jose)

Probable Anthropogenic Sources	Probable Natural Sources
Gravel or dirt roads	Wildlife other than waterfowl Weak soil structure

4.6 Linkage between Water Quality and Pollutant Sources

Aluminum is the third most common element in the Earth's crust, and the most common metal. It is a major component of the geology in the Rio Puerco headwaters, as evidenced by the predominance of alumino-silicate volcanic rocks in the region. In general, increased metals in the water column can be linked to sediment transport. This may be the case in Nacimiento and La Jara Creeks, as there is a positive relationship between TSS and total aluminum concentrations that exceed standards, as measured during the 2011 SWQB survey.

Aqueous Al is comprised of inorganic Al hydroxy species, of which gibbsite is the most abundant in the pH range encountered during the 2011 survey. Solubility and speciation are also affected by the presence of complexing ligands such sulfate or dissolved organic matter, and water temperature (Gensemer and Playle, 1999). Normal aqueous chemical processes, enhanced by the slight natural acidity of snow and rain, are capable of rendering some of the abundant, naturally-occurring aluminum available to the river system, and one would expect to see higher aluminum concentrations during the spring sampling events, as a result of snowmelt. The dataset indicates that exceedances occurred during the spring months, suggesting that the primary reason for presence of aluminum in surface water is natural erosional processes. Land disturbance in the watershed likely plays a role in the magnitude of soil erosion and transport.

The headwaters of Nacimiento and La Jara Creeks occur on land managed by the Santa Fe National Forest. The Forest recently adopted a Travel Management Plan (Record of Decision issued in 2012), to regulate the routes open or closed to various types of motorized vehicle use. Forestwide, it reduces the total acres available to drive and camp by 19 percent, acres on soils with an erosion hazard rating of moderate or severe by 18 percent, acres within 300 feet of all streams by 29 percent, and acres within 300 feet of impaired streams by 45 percent. The Plan also eliminates any legal motorized travel within 100 feet of perennial water. Roads, culverts and crossings with no traffic will continue to contribute excess sediment and storm flow to water bodies. The Forest Service estimates that natural recovery would take in excess of 15 years. Some routes, in order to completely return to natural condition, would require the Forest Service to physically decommission them. Closing them to motorized use is the first step, and it is likely that the forest will decommission some routes within the next 15 years.

The North Waste Rock Pile of the inactive and unreclaimed Nacimiento copper mine is in close proximity to the upper Nacimiento Creek SWQB monitoring station. SWQB does not have a monitoring station on Nacimiento Creek above the mine. In 2010, Golder Associates completed an Abatement Plan for the mine site (Golder Associates, Inc., 2011). As part of the site investigation, Golder conducted quarterly surface water sampling of Nacimiento Creek above and below the mine. Golder's laboratory results are not directly comparable to the state WQS for aluminum, as they were processed and analyzed for dissolved rather than total metals, but the similarity of results between their two locations indicates a lack of influence from the mine. Golder concluded that the "observed water quality likely reflects a background condition" of "aluminum leaching from the crystalline, feldspar-rich, Precambrian rocks that make up a large portion of the watershed". Supplemental metals samples were taken from Nacimiento Creek by SWQB on September 12, 2015, above and below the mine, to further evaluate potential mine site influence. Results of those samples confirmed the conclusion of no significant difference between locations (both samples had 0.3 mg/L of Al, compared to a chronic hardness-based standard of 1.15 mg/L). There is no potential for mine influence on La Jara Creek.

Aluminum is relatively insoluble at pH 6 to 8, but the solubility of Al increases under more acidic and more alkaline conditions, in the presence of complexing ligands, and at lower temperatures. There is an exchangeable fraction of Al with soils, sediments, and precipitated organic material(Gensemer and Playle, 1999). The pH at the upper Nacimiento Creek sampling station during the 2011 discrete sampling events averaged 8.19, with a low of 7.61 and a high of 8.48; exceedances of the calculated aluminum criteria occurred at lower pH levels (Figure 4.1). pH measurements recorded using a sonde deployed from August 17 to August 25, 2011 recorded an average value of 8.50, with a minimum reading of 7.56 and a maximum value of 8.65. The pH recorded during both types of events is within the range of 6.6 – 8.8 which is specified at NMAC 20.6.4.900.H (2).for the coldwater aquatic life use.

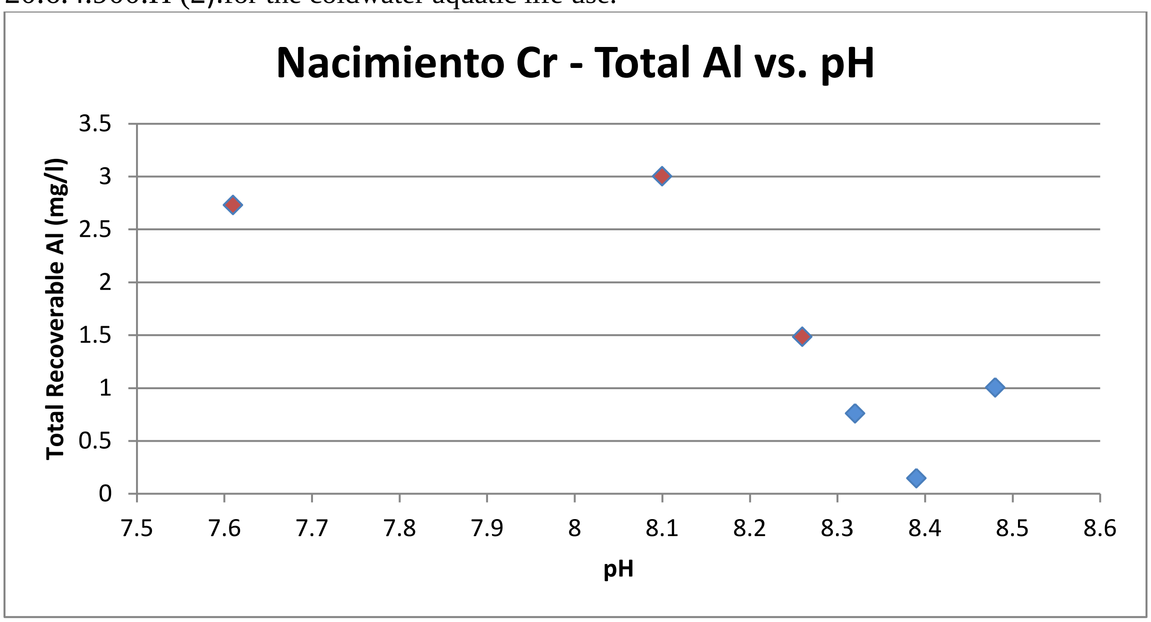


Figure 4.1 Total aluminum and pH in Nacimiento Creek discrete samples during the 2011 Rio Puerco survey. Data points in red indicate exceedance of calculated hardness-based chronic and/or acute WQCC standards.

The pH at the La Jara Creek sampling station during the 2011 discrete sampling events averaged 7.84, with a low of 6.98 and a high of 8.23; exceedances of the calculated criteria occurred at lower pH levels (Figure 5.2). pH measurements recorded using a sonde deployed from August 18 to August 25, 2011, recorded an average value of 7.93, with a minimum reading of 7.78 and a maximum value of 8.02. The pH recorded during both types of events is within the range of 6.6 – 8.8 which is specified at NMAC 20.6.4.900.H (2).for the coldwater aquatic life use.

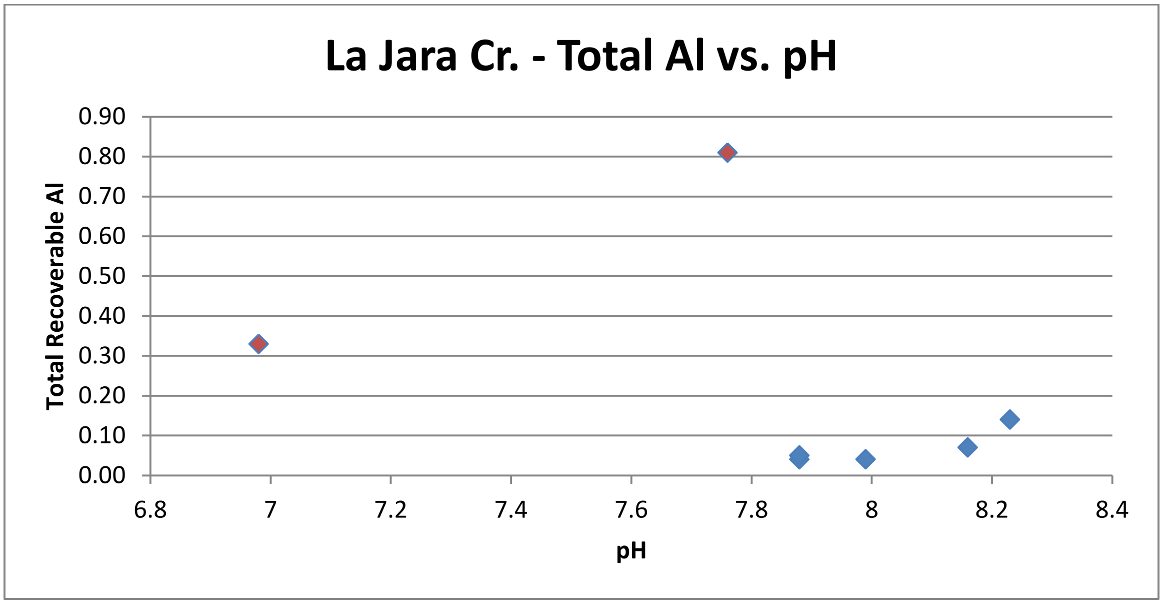


Figure 4.2 Total aluminum and pH in La Jara Creek discrete samples during the 2011 Rio Puerco survey. Data points in red indicate exceedance of calculated hardness-based chronic or acute WQCC standards.

Within the observed pH range, one would expect to see aluminum hydroxides such as gibbsite [$Al(OH)_3$] in both oxidizing or reducing conditions (Takeno, 2005). Some correlation of pH with dissociated Al^{3+} ions is to be expected, however correlation with polymeric colloidal forms is not expected (Hem and Roberson, 1967). It is not expected that pH will vary substantially in the AU, assuming the continuation of flow conditions and land management activities.

4.7 Consideration of Seasonal Variation

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs take into consideration seasonal variation in watershed conditions and pollutant loading. Data used in the calculation of these TMDLs were collected during the spring, summer, and fall of 2011 in order to ensure coverage of any potential seasonal variation in the system. As discussed above, probable source sheets indicate that various types of ground disturbance are the most commonly observed probable sources of surface water contamination in the watershed. In both streams with aluminum impairments, the exceedances occurred in the spring months, which coincided with lower pH measurements. In La Jara Creek, the exceedances and the lower pH also coincided with high flows; however in Nacimiento Creek, the exceedances occurred across a range of flow rates, indicating that pH may affect aluminum concentrations in this watershed irrespective of flow. Flow in these AUs is likely affected by irrigation withdrawals during the growing season.

4.8 Future Growth

Growth estimates by county are available from the New Mexico Bureau of Business and Economic Research. These estimates project growth to the year 2040. Sandoval County population is projected to increase in population by 72% over the 2015-2040 period, from 154,048 to 265,607 (UNM, 2012). The city of Rio Rancho is likely to be the major contributor to this projected growth. Rio Rancho is approximately 71 miles distant from Cuba, the population center nearest the La Jara Creek, Nacimiento Creek and upper Rio Puerco assessment units.

The estimate of future growth in Sandoval County may lead to a significant increase in stream water aluminum if additional residences are developed in the watersheds of Nacimiento and La Jara Creeks, or if additional recreational pressure is brought to bear within the Santa Fe National Forest. BMPs should continue to be utilized to avoid, minimize, and mitigate land disturbance, improve roads and low water crossings, and adhere to SWPPP requirements related to construction and industrial activities covered under the general permit. Any future growth would be considered part of the existing load allocation, assuming persistence of the hydrologic conditions used to develop these TMDLs.

5.0 URANIUM

Assessment of the data from the 2011 SWQB water quality survey in the Rio Puerco watershed identified exceedances of the New Mexico water quality standards for dissolved uranium in Nacimiento Creek (Perennial part northern boundary Cuba to headwaters). Consequently, this waterbody was listed on the 2012-2014 Integrated CWA §303(d) List (NMED/SWQB, 2012) for uranium.

Uranium is classified as a heavy metal and occurs mainly as a component of the earth's crust. Health effects related to natural uranium exposures are generally related to the chemical, rather than radiological, properties of uranium. Overall, absorption of uranium in the body is low, regardless of the route of exposure. Study of humans exposed to uranium showed the skeleton to be the primary long-term deposit site for ingested uranium. Soft tissue sites of deposition include the liver and kidneys. Uranium toxicity primarily affects the kidneys. Uranium has not been associated with human cancer (ATSDR, 2013).

5.1 Monitoring Results

Water quality samples were collected from Nacimiento Creek six times at Eureka Road and two times at Highway 126, between March 22 and September 7, 2011. Dissolved uranium concentrations exceeded the criterion one out of eight times, as shown on Table 5.1. To meet the Domestic Water Supply designated use, the Assessment Protocol (NMED/SWQB, 2013) specifies that, for any given pollutant, there shall be no exceedance of the criterion.

For this TMDL document, target values for uranium are based on the reduction in uranium necessary to achieve the numeric criterion associated with the domestic water supply use. The New Mexico water quality standards (20.6.4.900(J) NMAC) identify the uranium standard associated with DWS use as 30 ug/liter. This is the same concentration as the EPA maximum contaminant limit (MCL) for drinking water.

Table 5.1 Monitoring results for uranium in Nacimiento Creek

Sample Date	Uranium Criterion (ug/L)	Uranium Concentration (ug/L)	Measured Flow (cfs)
Nacimiento Creek at Eureka Road			
March 22, 2011	30	39(a)	1.5(b)
April 13, 2011	30	4	0.94
May 4, 2011	30	3	6.07
June 1, 2011	30	2	NA(b)
August 17, 2011	30	25	<1(b)
Sept 7, 2011	30	25	<1(b)
Nacimiento Creek at Highway 126			
May 13, 2011	30	10	3.29
June 1, 2011	30	23	<1(b)

(a) Indicates exceedence of the WQS criterion; (b) Flow based on a visual estimate; (c) Flow was not measured or estimated

5.2 Flow

TMDLs are calculated at a specific flow, and uranium concentrations can vary as a function of flow. SWQB determined streamflow by taking direct flow measurements utilizing standard procedures, or by visual estimate (NMED/SWQB, 2011). All of the uranium samples were collected at moderate flows, ranging from an estimated <1 cfs to 6.07 cfs, and the exceedance was reported at an intermediate flow.

According to the New Mexico Water Quality Standards (NMAC, 2013), the low flow critical condition is defined as the 4-day, 3-year low-flow frequency (4Q3, 20.6.4.11(B)(2) NMAC) for numeric criteria set in 20.6.4.97 through 20.6.4.900 NMAC, as well as Subsection F of 20.6.4.13 NMAC. The critical flow value used to calculate this TMDL was obtained using (4Q3) regression model. The 4Q3 is the annual lowest four (4) consecutive day flow that occurs with a frequency of at least once every three (3) years.

Because Nacimiento Creek is an ungaged stream, an analysis method developed by Waltemeyer (2002) was used to estimate the critical low flow. In Waltemeyer's analysis, two regression equations for estimating 4Q3 were developed based on physiographic regions of NM (i.e., statewide and mountainous regions above 7,500 ft in elevation). The average elevation of the Nacimiento Creek watershed is above 7,500 ft, so the mountainous regions regression equation (Equation 5.2) was used:

Equation 5.1

$$4Q3 = 7.3287 \times 10^{-5} DA^{0.70} P_w{}^{3.58} S^{1.35}$$

Where:

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (mi^2)
P_w = Average basin mean winter precipitation (inches)
S = Average basin slope (%)

The 4Q3 value calculated using Waltemeyer's methods is presented in Table 5.2. Parameters used in the calculation were determined using a GIS application. The 4Q3 result from Equation 7.2 is in cfs; it was converted to MGD for use in the TMDL.

It is important to remember that the TMDL itself is a value calculated at a defined critical condition as part of a planning process designed to achieve water quality standards. Since flows vary throughout the year in these systems, the actual load at any given time will vary based on the changing flow. Management of the load to improve stream water quality is the goal.

Table 5.2 Calculation of 4Q3 in Nacimiento Creek

Assessment Unit	Average Elevation (ft)	Drainage Area (mi^2)	Mean Winter Precipitation (in)	Average Basin Slope (percent)	4Q3 (cfs)	4Q3 (MGD)
Nacimiento Creek (Perennial part Hwy 126 to San Gregorio reservoir)	8174	7.62	13.16	0.189	0.33	0.213

5.3 Loading Capacity

This section describes the relationship between the numeric target and the allowable pollutant load by determining the total assimilative capacity of a waterbody, or loading capacity, for uranium. The loading capacity is the maximum amount of pollutant that a waterbody can receive at a given flow while meeting its water quality objectives. This TMDL was developed based on simple dilution calculations using the 4Q3 flow, the water quality standard, and a unit conversion factor (Equation 5.2, Table 5.3). The concentration values have been converted to milligrams per liter for the TMDL calculation.

Equation 5.2

$$Critical\ Flow\ (4Q3) \times WQS \times Unit\ Conversion\ Factor = Target\ Loading\ Capacity\ (TMDL)$$

Table 5.3 Target load for uranium in Nacimiento Creek

Assessment Unit	4Q3 (MGD)	WQS Criterion	Unit Conversion	TMDL[(a)]

		(mg/L)	Factor	(lbs/day)
Nacimiento Creek (Perennial part Hwy 126 to San Gregorio reservoir)	0.213	0.03	8.34	0.053

(a) TMDL = Target Load Capacity

By applying Equation 5.2 to uranium, it is determined that Nacimiento Creek can transport approximately 0.053 lbs/day of uranium during critical low-flow conditions during which instream concentrations should not exceed 1.11 ug/L, at an average hardness of 350 mg/L $CaCO_3$.

The measured load for uranium was calculated using data only from the exceedance event. In order to achieve comparability between the target and measured loads, the same flow value was used for both calculations. The collected data was substituted for the numeric target in Equation 5.2. The same unit conversion factor was utilized. The calculated measured load is shown in Table 5.4.

Table 5.4 Measured uranium load in Nacimiento Creek

Assessment Unit	4Q3 (MGD)	Measured Load (mg/L)	Unit Conversion Factor	Measured Load (lbs/day)
Nacimiento Creek (Perennial part Hwy 126 to San Gregorio reservoir)	0.213	0.039	8.34	0.069

The load reduction necessary to meet the target load was calculated to be the difference between the calculated Target Load (Table 5.3) and the measured load (Table 5.4), as shown in Table 5.5.

Table 5.5 Percent reduction for uranium to meet target load in Nacimiento Creek

Assessment Unit	Target Load (lbs/day)	Measured Load (lbs/day)	Load Reduction (lbs/day)	Percent Reduction (%)[(a)]
Nacimiento Creek (Perennial part Hwy 126 to San Gregorio reservoir)	0.053	0.069	0.016	23.2

5.4 Margin of Safety and Allocations

5.4.1 Margin of Safety

TMDLs should reflect a MOS based on the uncertainty or variability in the data, the point and nonpoint source load estimates, and the modeling analysis. For this uranium TMDL, the MOS was developed using a combination of conservative assumptions and inputs and explicit recognition of potential errors in flow calculations. Therefore, the MOS is the sum of the following assumptions:

- Conservative Assumptions:
    - Uranium does not readily degrade in the environment.

- Explicit recognition of potential errors:
    - Uncertainty exists in sampling nonpoint sources of pollution. A conservative MOS for this element is therefore **5%**.
    - Critical flow was determined using a regression equation based on sites statewide. There is inherent error in using this equation; a conservative MOS for this element is **10%**.

The total MOS for this TMDL is **15%**.

5.4.2 Waste Load Allocation

There are no existing permitted point sources along this assessment unit, nor any identified MS4 or Municipal Separate Storm Sewer (MS4) areas in the watershed.

In contrast to discharges from other industrial stormwater and individual process wastewater permitted facilities, stormwater discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the NPDES Construction General Permit (CGP) requires preparation of a Storm Water Pollution Prevention Plan (SWPPP) that includes identification and control of all pollutants associated with the construction activities to minimize impacts to water quality. In addition, the current CGP also includes state-specific requirements to implement BMPs that are designed to prevent, to the maximum extent practicable, an increase in sediment or a parameter that addresses sediment (e.g., TSS, turbidity, siltation, stream bottom deposits) and flow during and after construction compared to pre-construction conditions. In this case, compliance with a SWPPP that meets the requirement of the CGP is generally assumed to be consistent with this TMDL.

Stormwater discharges from active industrial facilities are generally covered under the current NPDES Municipal Stormwater General Permit (MSGP). This permit also requires preparation of an SWPPP, which includes specific requirements to limit (or eliminate) pollutant loading associated with the industrial activities in order to minimize impacts to water quality. Compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL.

It is not possible to calculate individual WLAs for facilities covered by the MSGP at this time using readily available tools. The discharges from these permits are typically transitory and enforcement is complex as permittees are temporary. Loads that are in compliance with the MSGP are therefore currently included as part of the LA. While these sources are not given individual allocations, they are addressed through other means, including BMPs, stormwater pollution prevention conditions, and other requirements.

5.4.3 Load Allocation

In order to calculate the LA for uranium, the MOS was subtracted from the target load (TMDL) using Equation 5.3:

Equation 5.3

$$LA + MOS = TMDL$$

Or

$$LA = TMDL - MOS$$

Table 5.6 presents how the TMDL was allocated between nonpoint sources and the MOS.

Table 5.6 TMDL for uranium in Nacimiento Creek

Assessment Unit	**TMDL (lbs/day)**	**MOS (15%) (lbs/day)**	**LA (lbs/day)**
Nacimiento Creek (Perennial part Hwy 126 to San Gregorio reservoir)	53×10^{-3}	7.95×10^{-3}	45.1×10^{-3}

5.5 Identification and Description of Pollutant Sources

SWQB fieldwork includes an assessment of the probable sources of impairment. The approach for identifying probable sources of impairment includes additional input from a variety of stakeholders including landowners, watershed groups, and local, state, tribal, and federal agencies. Probable source sheets are filled out by SWQB staff during watershed surveys and watershed restoration activities. The draft probable source list was reviewed and modified as necessary with watershed group/stakeholder input during the TMDL public meeting and comment period. See a full description of the probable source documentation process, and the completed sheets for the upper Rio Puerco impaired AUs, in Appendix B.

Although this procedure includes subjective and qualitative elements, SWQB has concluded that it provides the best available information for the identification of probable sources of impairment in a watershed. The list of probable sources is not intended to single out any individual land owner or particular land management activity and generally includes several sources per impairment. Pollutant sources that may contribute to each segment were determined by field reconnaissance and evaluation (Table 5.7). Probable sources of uranium impairments will be evaluated, refined, and changed as necessary through the WBP.

Table 5.7 Probable source summary for uranium in Nacimiento Creek (Perennial part Hwy 126 to San Gregorio reservoir)

Probable Anthropogenic Sources	Probable Natural Sources
Channelization	Drought-related impacts
Dams/diversion	Recent bankfull or overbank flows
Riprap wall	Wildlife other than waterfowl
Highway/road/bridge runoff	High clay content in soils
Impervious surfaces	
Inappropriate waste disposal	
Residences/buildings	
Abandoned mine tailings	
Rangeland grazing	
Low water crossing	
Exotic species	

5.6 Linkage between Water Quality and Pollutant Sources

In general, increased metals in the water column can be linked to sediment transport. However, this may not be the case in Nacimiento Creek with respect to uranium, as there is no evident relationship between TSS and uranium concentrations, as measured during the 2011 SWQB survey. Heavy metals are often present in stormwater runoff in dissolved phases, but a large fraction of most metals are bound to suspended solids. Additionally, heavy metals do not degrade in the environment, so uranium in soil will persist until it is transported into the stream (Pitt *et al*., 1996; Weiss *et al*., 2008) through land disturbance or natural processes.

The headwaters of Nacimiento and La Jara Creeks occur on land managed by the Santa Fe National Forest. The Forest recently adopted a Travel Management Plan (Record of Decision issued in 2012), to regulate the routes open or closed to various types of motorized vehicle use. Forestwide, it reduces the total acres available to drive and camp by 19 percent, acres on soils with an erosion hazard rating of moderate or severe by 18 percent, acres within 300 feet of all streams by 29 percent, and acres within 300 feet of impaired streams by 45 percent. The Plan also eliminates any legal motorized travel within 100 feet of perennial water. Roads, culverts and crossings with no traffic will continue to contribute excess sediment and storm flow to water bodies. The Forest Service estimates that natural recovery would take in excess of 15 years. Some routes, in order to completely return to natural condition, would require the Forest Service to physically decommission them. Closing them to motorized use is the first step, and it is likely that the forest will decommission some routes within the next 15 years.

The North Waste Rock Pile of the inactive and unreclaimed Nacimiento copper mine is in close proximity to the upper SWQB monitoring station. SWQB does not have a monitoring station on Nacimiento Creek above the mine. In 2010, Golder Associates completed an Abatement Plan for the mine site (Golder Associates, Inc., 2011). As part of the site investigation, Golder conducted quarterly surface water sampling of Nacimiento Creek above and below the mine. They detected uranium above the WQS drinking water standard in three out of four sampling events, at both locations. Concentrations were similar between the two locations, indicating a lack of influence from the mine. Golder concluded that the observed water quality “likely reflects a background condition” of “uranium . . . suspected to come from natural mineralization”. Supplemental metals samples were taken from Nacimiento Creek by SWQB on September 12, 2015, above and below the mine, to further evaluate potential mine site influence. Results of those samples confirmed the conclusion of no significant difference between locations (both results were 5 ug/L).

The pH at the upper Nacimiento Creek sampling station during the 2011 discrete sampling events averaged 8.19, with a low of 7.61 and a high of 8.48; the exceedance of the uranium criterion occurred at a higher pH level (Figure 5.1). pH measurements recorded using a sonde deployed from August 17 to August 25, 2011 recorded an average value of 8.50, with a minimum reading of 7.56 and a maximum value of 8.65. The pH recorded during both types of events is within the range of 6.6 – 8.8 which is specified at NMAC 20.6.4.900.H (2) for the coldwater aquatic life use.

Within the observed pH range, one would expect to see U in the form of uranyl carbonate. It is not expected that pH will vary substantially in the AU, assuming the continuation of flow conditions and land management activities.

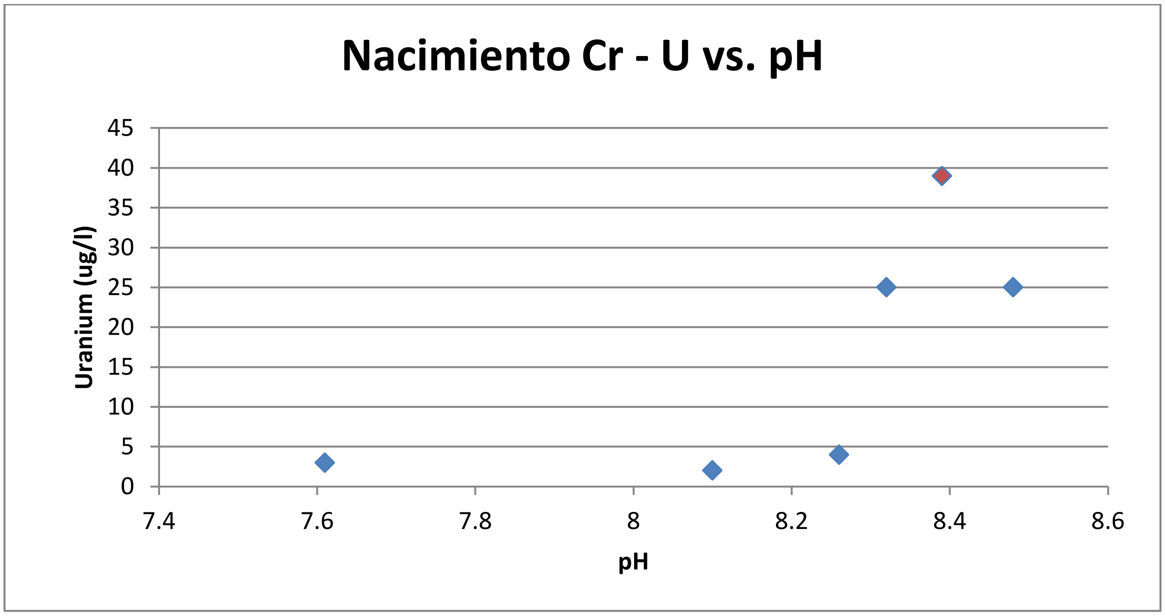


Figure 5.1 Uranium and pH in Nacimiento Creek discrete samples during the 2011 Rio Puerco survey. Data point in red indicates exceedance of the WQCC standard.

5.7 Consideration of Seasonal Variation

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs take into consideration seasonal variation in watershed conditions and pollutant loading. Data used in the calculation of these TMDLs were collected during the spring, summer, and fall of 2011 in order to ensure coverage of any potential seasonal variation in the system. The uranium exceedance occurred during the earliest spring sampling event, possibly indicating the influence of snowmelt rather than sediment mobilization by rainfall, but uranium concentrations during other sampling events did not show a clear pattern of seasonal variation. Uranium concentration in Nacimiento Creek generally appears to increase at lower flow rates and higher pH. Flow in this AU is likely affected by irrigation withdrawals during the growing season.

5.8 Future Growth

Growth estimates by county are available from the New Mexico Bureau of Business and Economic Research. These estimates project growth to the year 2040. Sandoval County population is projected to increase in population by 72% over the 2015-2040 period, from 154,048 to 265,607 (UNM, 2012). The city of Rio Rancho is likely to be the major contributor to this projected growth. Rio Rancho is approximately 71 miles distant from Cuba, the population center nearest the La Jara Creek, Nacimiento Creek and upper Rio Puerco assessment units.

The estimate of future growth in Sandoval County may lead to a significant increase in stream water aluminum if additional residences are developed in the watersheds of Nacimiento and La Jara Creeks, or if additional recreational pressure is brought to bear within the Santa Fe National Forest. BMPs should continue to be utilized to avoid, minimize, and mitigate land disturbance, improve roads and low water crossings, and adhere to SWPPP requirements related to construction and industrial activities covered under the general permit. Any future growth would be considered part of the existing load allocation, assuming persistence of the hydrologic conditions used to develop these TMDLs.

6.0 TURBIDITY

During the 2011 survey, exceedances of numeric turbidity thresholds resulting in an impairment of the narrative criterion for turbidity in 20.6.4.13 NMAC were documented in Nacimiento Creek. The general narrative standard for turbidity reads:

> *"Turbidity attributable to other than natural causes shall not reduce light transmission to the point that the normal growth, function, or reproduction of aquatic life is impaired or that will cause substantial visible contrast with the natural appearance of the water…"*

The impacts of suspended sediment and turbidity are well documented in the literature. An increased sediment load is often the most important adverse effect of human activities on streams, according to a monitoring guidelines report (USEPA, 1991). An increase in suspended sediment concentration will reduce the penetration of light, decreases the ability of fish or fingerlings to capture prey, and reduce primary production (USEPA, 1991). As stated in Relyea *et al.* (2000), "increased turbidity by sediments can reduce stream primary production by reducing photosynthesis, physically abrading algae and other plants, and preventing attachment of autotrophs to substrate surfaces."

The assessment approach used to determine turbidity impairments is described in detail in the 2013 Assessment Protocol (NMED/SWQB, 2013). Target values for this TMDL were based on the turbidity thresholds identified in the Assessment Protocol. It relies upon the use of biotranslators to derive numeric thresholds from the narrative standard above. A biotranslator is a physical or chemical water quality parameter that has been isolated and effects an impairment of a quantifiable attribute of an indicator organism. In some cases, the quantifiable attribute may be the lethal dose or concentration of the parameter. In the case of turbidity, the attribute is typically based upon observed behavior and the Severity of Ill Effects ("SEV") index,

The Nacimiento Creek AU has a designation for coldwater aquatic life use. The most representative fish to use in determining the appropriate turbidity thresholds for coldwater aquatic life stream segments are salmonids, as a majority of studies on turbidity in fish have been conducted with them. The numeric thresholds in Assessment Protocol have also been supported with studies of turbidity effects on benthic macroinvertebrates.

An SEV of 3.5 was selected to develop thresholds for turbidity impairment in New Mexico. This SEV index value corresponds to the boundary between conditions that effect changes to feeding in aquatic organisms and conditions that have been found to reduce growth rate and habitat size. The relationship between turbidity, duration, and an SEV of 3.5 is given in Equation 6.1, where x is duration in hours and y is the turbidity in Nephelometric Turbidity Units (NTUs) for durations from 7 hours to 720 hours. Shorter-term turbidity excursions are unlikely to impair the growth, function, and reproduction of aquatic life as required by New Mexico's narrative turbidity water quality criterion, while thresholds for durations longer than 720 consecutive hours result in turbidity values that are lower than supported by literature available at the time of the assessment protocol development. The Assessment Protocol provides a series of turbidity thresholds and durations which are listed in Table 6.1.

Equation 6.1 $x = 37{,}382y^{-1.9887}$

Where:

x = duration (hours)

y = turbidity (NTU)

Applicable for durations between 7 and 720 hours

Table 6.1 Turbidity impairment thresholds and durations from the 2013 SWQB Assessment Protocol

Turbidity Threshold (NTU)	Allowable Duration (consecutive hours)	Allowable Duration (consecutive days)
23	72	3
20	96	4
18	120	5
16	144	6
15	168	7
11	336	14
7	720	30

NTU = Nephelometric Turbidity Units

6.1 Monitoring Results

Turbidity in Nacimiento Creek was measured using a sonde multiparameter datalogger placed at the Eureka Road sampling station from August 11 to August 25, 2011. During that deployment, turbidity exceeded 23 NTU for more than 72 hours, thus exceeding the threshold on Table 6.1.

Because a TMDL requires a mass-based numeric loading component which cannot be directly derived from turbidity, previous SWQB TMDLs have used Total Suspended Solids (TSS) as a turbidity surrogate. TSS is a commonly-used measurement of suspended material in surface water because it is acceptable for regulatory purposes and is an inexpensive laboratory procedure. Since there are no facilities with NPDES permits discharging into or upstream of the Nacimiento Creek AU, it is assumed that TSS measurements in these ambient stream samples are representative of erosional activities, re-suspension of bedded sediments, or biosolids from livestock or wildlife, and thus comprised primarily of suspended sediment versus any potential biosolids from WWTP effluent.

A relationship can typically be found between turbidity and TSS in a watershed or waterbody. Hence, suspended sediment levels may be inferred from turbidity studies; alternatively, turbidity levels may be inferred from studies that monitor suspended sediment concentrations. Extrapolation from these studies is possible when a site-specific relationship between concentrations of suspended sediments and turbidity is confirmed. Activities that generate varying amounts of suspended sediment will proportionally change or affect turbidity (USEPA, 1991). Turbidity and TSS results in Nacimiento Creek from the 2011 survey are shown on Table 6.2.

The R^2 (coefficient of determination) value is a measure of how well a dataset fits the applied model; R^2 values approaching one are considered better fits than R^2 values approaching zero. Based on the R^2 value, a second order polynomial regression equation offers the best fit for the data from Nacimiento Creek. The equation and regression statistics are displayed in Figure 6.1. Data from the 2004 survey were added to Figure 6.1 in order to increase the number of data points, and to include some higher turbidity values more similar to those documented during the August 2011 sonde deployment.

Table 6.2 Discrete (grab sample) turbidity and TSS data for Nacimiento Ck (Perennial prt HWY 126 to San Gregorio Rsvr)

Monitoring Station	Date	Turbidity (NTU)	TSS (mg/L)	Flow (cfs)
Nacimiento Creek at Eureka Rd. - 33Nacimi008.0	3/22/11	2.6	5	1.5 [(a)]
	4/13/11	116	111	0.94
	5/4/11	83.2	62	6.07
	6/1/11	47.4	41	1.56
	8/17/11	13.4	24	<1 [(a)]
	9/7/11	66.8	224	<1 [(a)]
Nacimiento Creek at Hwy 126 - 33Nacimi003.4	5/13/11	48.2	28	3.29
	6/1/2011	6.3	ND	<1 [(a)]

(a) Flow based on a visual estimate

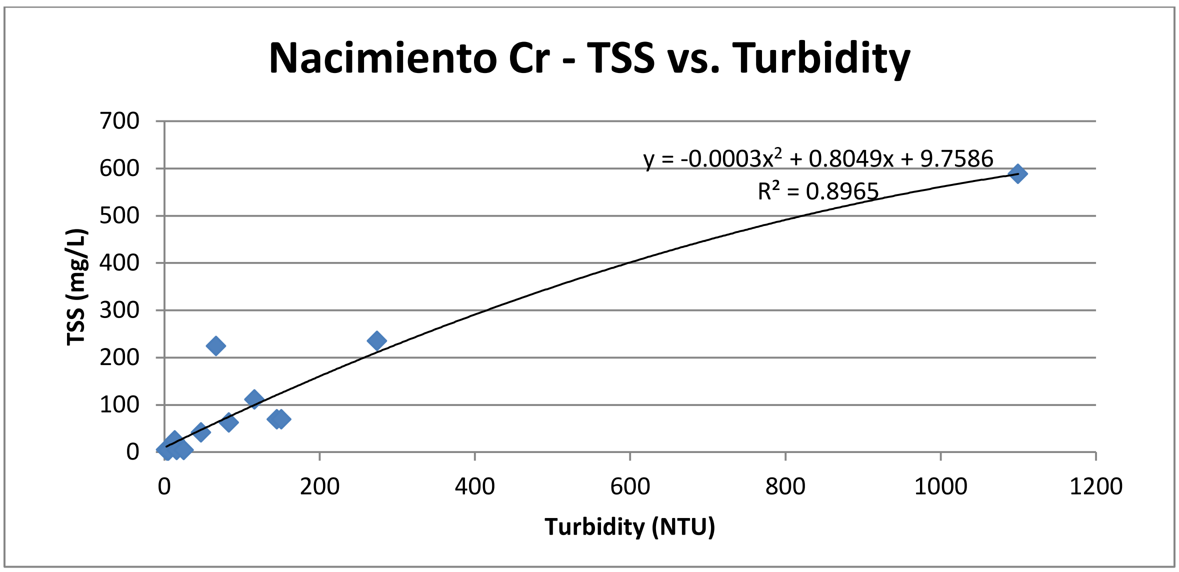


Figure 6.1 Relationship between turbidity and TSS in Nacimiento Creek during 2004 and 2011 surveys.

6.2 Flow

According to the New Mexico Water Quality Standards (NMAC, 2013), the low flow critical condition is defined as the 4-day, 3-year low-flow frequency (4Q3, 20.6.4.11(B)(2) NMAC) for numeric criteria set in 20.6.4.97 through 20.6.4.900 NMAC, as well as Subsection F of 20.6.4.13

NMAC. Based on the grab sample data depicted on Table 6.2, there was no apparent relationship between stream discharge and turbidity or TSS. The critical flow value used to calculate the TMDL was obtained using a regression model. The 4Q3 is the annual lowest four (4) consecutive day flow that occurs with a frequency of at least once every three (3) years.

Because Nacimiento Creek is an ungaged stream, an analysis method developed by Waltemeyer (2002) was used to estimate the critical low flow. In Waltemeyer's analysis, two regression equations for estimating 4Q3 were developed based on physiographic regions of NM (i.e., statewide and mountainous regions above 7,500 ft in elevation). The average elevation of this watersheds is above 7,500 ft, so the mountainous regions regression equation was used.

The following mountainous regions regression equation (Equation 6.2) is based on data from 40 gaging stations located above 7,500 ft in elevation with non-zero discharge (Waltemeyer 2002):

Equation 6.2

$$4Q3 = 7.3287 \times 10^{-5} DA^{0.70} {P_w}^{3.58} S^{1.35}$$

Where:

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (mi^2)
P_w = Average basin mean winter precipitation (inches)
S = Average basin slope (%)

The 4Q3 value calculated using Waltemeyer's method is presented in Table 6.3. Parameters used in the calculation were determined using a GIS application called Basins. The TMDL itself is a value calculated at a defined critical condition as part of a planning process designed to achieve water quality standards. Since flows vary throughout the year in these systems, the actual load at any given time will vary based on the changing flow. Management of the load to improve stream water quality is the goal of SWQB efforts.

Table 6.3 Calculation of 4Q3 in Nacimiento Creek

Assessment Unit	Average Elevation (ft)	Drainage Area (mi^2)	Mean Winter Precipitation (in)	Average Basin Slope (percent)	4Q3 (cfs)	4Q3 (MGD)
Nacimiento Creek (Perennial part Hwy 126 to San Gregorio reservoir)	8174	7.62	13.16	0.189	0.33	0.213

6.3 Loading Capacity

This section describes the relationship between the numeric target and the allowable pollutant load by determining the total assimilative capacity of a waterbody, or loading capacity, for turbidity. The loading capacity is the maximum amount of pollutant that a waterbody can receive, at a specific flow, while meeting its water quality objectives. Because impairment of a waterbody is dependent on the duration of elevated turbidity, a separate TMDL has been determined for each NTU/duration threshold identified in the turbidity assessment protocol. This TMDL was developed using the turbidity/duration thresholds identified in the SWQB turbidity assessment protocol, the site-specific relationship between turbidity and TSS, the 4Q3 flow condition, and a unit conversion factor to translate the target value into pounds per day (lbs/day). Using the regression equation provided in Figure 6.1, TSS values for each turbidity threshold were calculated (Table 6.4).

Table 6.4 Calculated TSS threshold values for Nacimiento Creek (Perennial part Hwy 126 to San Gregorio reservoir)

Turbidity (NTU)	TSS (mg/L)	Duration (consecutive hrs)
7	15.38	720
11	18.58	336
15	21.76	168
16	22.56	144
18	24.15	120
20	25.74	96
23	28.11	72

The TSS values calculated in Table 6.4 were substituted into Equation 6.3 to determine the target loading capacity at each turbidity/duration threshold (Table 6.5).

Equation 6.3

$$Critical\ Flow\ \times WQS \times Unit\ Conversion\ Factor = Target\ Loading\ Capacity\ (TMDL)$$

Note that the target load is the TMDL for a particular turbidity/duration pairing. It should not be extrapolated to longer or shorter durations.

Table 6.5 Turbidity-TSS/Duration TMDLs for Nacimiento Creek

Duration (consecutive hrs)	Duration (consecutive days)	TSS Target (mg/L)	4Q3 (MGD)	Conversion Factor	Target Load (lbs/day)
720	30	15.38	0.213	8.34	27.32
336	14	18.58	0.213	8.34	33.01
168	7	21.76	0.213	8.34	38.65
144	6	22.56	0.213	8.34	40.08
120	5	24.15	0.213	8.34	42.90
96	4	25.74	0.213	8.34	45.73
72	3	28.11	0.213	8.34	49.94

6.4 Margin of Safety and Allocations

6.4.1 Margin of Safety

TMDLs should reflect a MOS based on the uncertainty or variability in the data, the point and nonpoint source loading estimates, and the modeling analysis. The MOS can be expressed implicitly, explicitly, or a combination of the two. An implicit MOS is incorporated by making conservative assumptions in the TMDL analysis, such as allocating a conservative load to background sources. An explicit MOS is applied by reserving a portion of the TMDL and not allocating it to any other sources.

For the turbidity TMDLs presented in this document, there are no permitted point sources on the reaches, so there will be no MOS associated with point sources. The MOS for the TMDLs was developed using a combination of conservative assumptions and allocating an explicit portion of the TMDL in recognition of potential errors. Therefore, this MOS is the sum of the following two elements:

- Conservative Assumptions:
  - TSS is a conservative parameter that does not settle out of the water column.

- Explicit Recognition of Potential Errors:
  - Uncertainty exists in the relationship between TSS and turbidity. A conservative MOS for this element is **5%**.
  - The critical flow value for the ungaged streams was estimated based on a regression equation from Waltemeyer (2002). There is inherent error in all flow calculations. A conservative MOS for this element for AUs which used the regression equation is therefore **10%**.

Total MOS for this TMDL is **15%**.

6.4.2 Waste Load Allocation

There are no individually permitted point source facilities or MS4/sMS4 stormwater permits in this assessment unit. Sediment may be a component of some (primarily construction) stormwater discharges that contribute to suspended sediment impacts, and should be addressed.

In contrast to discharges from other industrial stormwater and individual process wastewater permitted facilities, stormwater discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the NPDES CGP requires preparation of a SWPPP that includes identification and control of all pollutants associated with the construction activities to minimize impacts to water quality. In addition, the current CGP also includes state-specific requirements to implement BMPs that are designed to prevent the maximum extent practicable, an increase in sediment or a parameter that addresses sediment (e.g., TSS, turbidity, siltation, stream bottom deposits, etc.), and flow velocity during and after construction compared to pre-construction conditions. In this case, compliance with a SWPPP that meets the requirements of the CGP is generally assumed to be consistent with this TMDL.

Other industrial stormwater facilities are generally covered under the current NPDES MSGP. This permit also requires the preparation of a SWPPP that includes identification and control of all pollutants associated with the industrial activities to minimize impacts to water quality. In addition, the current MSGP also includes state-specific requirements to further limit (or eliminate pollutant loading) to water quality impaired/water quality limited waters from facilities where there is a reasonable potential to contain pollutants for which the receiving water is impaired. In this case, compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL. It is not possible to calculate individual WLAs for facilities covered by the MSGP at this time using available tools. The discharges from the MSGP are typically transitory and enforcement is complex as permittees are temporary. Loads that are in compliance with the General Permits are therefore currently included as part of the LA. While these sources are not given individual allocations, they are addressed through other means, including BMPs, stormwater pollution prevention conditions, and other requirements.

6.4.3 Load Allocation

In order to calculate the LA for turbidity, the MOS was subtracted from the target load (TMDL) using the following Equation 6.4:

Equation 6.4

$$LA + MOS = TMDL$$

Or

$$LA = TMDL - MOS$$

The MOS was developed using a combination of conservative assumptions and explicit recognition of potential errors. The explicit MOS is estimated to be 15% of the target load calculated in Table 6.5. The TMDLs were allocated per Equation 6.4 and the resulting allocations are listed in Tables 6.6.

Table 6.6 TMDLs for Turbidity in Nacimiento Creek

Duration (consecutive hrs)	WLA (lbs/day)	TMDL (lbs/day)	MOS (15%) (lbs/day)	LA (lbs/day)
720	0.00	27.32	4.10	23.22
336	0.00	33.01	4.95	28.06
168	0.00	38.65	5.80	32.85
144	0.00	40.08	6.01	34.07
120	0.00	42.90	6.44	36.46
96	0.00	45.73	6.86	38.87
72	0.00	49.94	7.49	42.45

6.5 Identification and Description of Pollutant Sources

SWQB fieldwork includes an assessment of the probable sources of impairment. The approach for identifying probable sources of impairment includes additional input from a variety of stakeholders including landowners, watershed groups, and local, state, tribal, and federal agencies. Probable source sheets are filled out by SWQB staff during watershed surveys and watershed restoration activities. The draft probable source list was reviewed and modified as necessary with watershed group/stakeholder input during the TMDL public meeting and comment period. See a full description of the probable source documentation process, and the completed sheets for the upper Rio Puerco impaired AUs, in Appendix B.

Although this procedure includes subjective and qualitative elements, SWQB has concluded that it provides the best available information for the identification of probable sources of impairment in a watershed. The list of probable sources is not intended to single out a particular land owner or land management activity and generally includes several potential sources per impairment. Table 6.7 displays pollutant sources that may contribute to each segment as determined by field reconnaissance and evaluation. Probable sources of turbidity impairments will be evaluated, refined, and changed as necessary through the WBP.

Table 6.7 Probable source summary for turbidity in Nacimiento Creek

Probable Anthropogenic Sources	Probable Natural Sources
Channelization	Drought-related impacts
Dams/diversion	Recent bankfull or overbank flows
Riprap wall	Wildlife other than waterfowl
Highway/road/bridge runoff	High clay content in soils
Impervious surfaces	
Inappropriate waste disposal	
Residences/buildings	
Abandoned mine tailings	
Rangeland grazing	
Low water crossing	
Exotic species	

6.6 Linkage between Water Quality and Pollutant Sources

Turbidity is an expression of the optical property in water that causes incident light to be scattered and absorbed rather than transmitted in straight lines. It is the condition resulting from suspended solids in the water, including silts, clays, and plankton. Such particles absorb heat in the sunlight, thus raising water temperature, which in turn lowers dissolved oxygen levels. It also prevents sunlight from reaching plants below the surface. This decreases the rate of photosynthesis, so less oxygen is produced by plants. Turbidity may harm fish and their larvae. Turbidity exceedances have historically been attributed to soil erosion, excess nutrients, various wastes and pollutants, and the re-suspension of sediments up into the water column during high flow events.

As observed in SWQB data, turbidity values along this reach exceed the applicable standard for the protection of designated uses. The most likely causes for this exceedance are increased land disturbance and changing land use. The components of a watershed continually change through natural ecological processes such as vegetation succession, erosion, and evolution of stream channels. Human activity often affects watershed function in ways that are inconsistent with the natural balance. These changes, often rapid and sometimes irreversible, occur when people cut forests, clear and cultivate land, remove stream-side vegetation, alter the drainage of the land, channelize watercourses, withdraw water for irrigation, build towns and cities, and discharge pollutants into waterways. Disturbances may be historical or current in nature.

Possible effects of these practices on aquatic ecosystems include increased amount of sediment carried into water by soil erosion, which may increase turbidity of the water, reduce transmission of sunlight needed for photosynthesis, interfere with animal behaviors dependent on sight (foraging, reproduction, and escape from predators), impede respiration (e.g., by gill abrasion and congestion in fish) and digestion, and reduce oxygen in the water. Clearing of trees and shrubs from shoreline may destabilize banks and promote erosion, increase sedimentation and turbidity, reduce shade and increase water temperature which could disrupt fish metabolism, and cause channels to widen and become shallower. Land clearing, constructing drainage ditches, and straightening natural water channels may create an obstacle to upstream movement of fish and suspend more sediment in the water due to increased flow, strand fish upstream and dry out recently spawned eggs due to subsequent low flows, and reduce base flows.

The headwaters of Nacimiento and La Jara Creeks occur on land managed by the Santa Fe National Forest. The Forest recently adopted a Travel Management Plan (Record of Decision issued in 2012), to regulate the routes open or closed to various types of motorized vehicle use. Forestwide, it reduces the total acres available to drive and camp by 19 percent, acres on soils with an erosion hazard rating of moderate or severe by 18 percent, acres within 300 feet of all streams by 29 percent, and acres within 300 feet of impaired streams by 45 percent. The Plan also eliminates any legal motorized travel within 100 feet of perennial water. Roads, culverts and crossings with no traffic will continue to contribute excess sediment and storm flow to water bodies. The Forest Service estimates that natural recovery would take in excess of 15 years. Some routes, in order to completely return to natural condition, would require the Forest Service to physically decommission them. Closing them to motorized use is the first step, and it is likely that the forest will decommission some routes within the next 15 years.

Where data gaps exist or the level of uncertainty in the characterization of sources is large, the recommended approach to TMDL assignments requires the development of allocations based on estimates utilizing the best available information. Additional turbidity and TSS sampling are needed in the referenced reaches to more fully characterize probable sources of turbidity. However, sufficient data exist to support development of turbidity TMDLs to address the stream standards exceedences.

6.7 Consideration of Seasonal Variation

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs take into consideration seasonal variation in watershed conditions and pollutant loading. Sonde data used to document the Nacimiento Creek turbidity exceedance were taken in late summer of 2011. Higher turbidity values are typically associated with higher flows, which were noted in the SWQB dataset during the late spring of that year. However, as precipitation events are infrequent and transitory in nature, the 4Q3 is considered a more conservative estimate of the long-term stream condition. Since the critical flow condition is set to estimate critical low flow discharge, it is assumed that if critical conditions are met, coverage of any potential seasonal variation will also be met. Flow in this AU is likely affected by irrigation withdrawals during the growing season.

6.8 Future Growth

Growth estimates by county are available from the New Mexico Bureau of Business and Economic Research. These estimates project growth to the year 2040. Sandoval County population is projected to increase in population by 72% over the 2015-2040 period, from 154,048 to 265,607 (UNM, 2012). The city of Rio Rancho is likely to be the major contributor to this projected growth. Rio Rancho is approximately 71 miles distant from Cuba, the population center nearest the La Jara Creek, Nacimiento Creek and upper Rio Puerco assessment units.

The estimate of future growth in Sandoval County may lead to a significant increase in stream water aluminum if additional residences are developed in the watersheds of Nacimiento and La Jara Creeks, or if additional recreational pressure is brought to bear within the Santa Fe National Forest. BMPs should continue to be utilized to avoid, minimize, and mitigate land disturbance, improve roads and low water crossings, and adhere to SWPPP requirements related to construction and industrial activities covered under the general permit. Any future growth would be considered part of the existing load allocation, assuming persistence of the hydrologic conditions used to develop these TMDLs.

7.0 SEDIMENTATION

The general narrative standard for "bottom deposits and suspended or settleable solids" reads:

"Surface waters of the state shall be free of water contaminants including fine sediment particles (less than two millimeters in diameter), precipitates or organic or inorganic solids from other than natural causes that have settled to form layers on or fill the interstices of the natural or dominant substrate in quantities that damage or impair the normal growth, function or reproduction of aquatic life or significantly alter the physical or chemical properties of the bottom."

Stream bottom substrate provides optimum habitat for many fish and aquatic insect communities when it does not include excessive fine sediment filling the interstitial spaces. Excessive fine sediment occurs when biologically-important habitat components such as spawning gravels and cobble surfaces are physically covered by fines (Chapman and McLeod 1987). Substrate fining decreases intergravel oxygen and results in reduced or eliminated quality and quantity of habitat for fish, macroinvertebrates, and algae (Lisle 1989; Waters 1995). Chapman and Mcleod (1987) found that bed material size is related to habitat suitability for fish and macroinvertebrates and that excess fine sediment decreased both density and diversity of aquatic insects.

Sediment loads that exceed a stream's sediment transport capacity often trigger changes in stream morphology (Leopold et al, 1964). Streams that become overwhelmed with sediment often go through a period of accelerated channel widening and streambank erosion before returning to a stable form (Rosgen 1996). These morphological changes can accelerate erosion, reduce habitat diversity (pools, riffles, etc.) and place additional stress on the designated aquatic life use.

The assessment approach used to determine sedimentation impairments is described in detail in the 2013 Assessment Protocol (NMED/SWQB, 2013). Target values for this TMDL were based on the numeric thresholds identified in the Assessment Protocol. The Assessment Protocol establishes a procedure for determining impairment due to excessive sedimentation/siltation in perennial, wadeable streams. Bedded sediments cannot be treated as introduced pollutants such as pesticides because they are not uniquely generated through human input or disturbance. Rather, bedded sediments are components of natural systems that are present even in pristine settings and to which stream organisms have evolved and adapted. Therefore, the detection of a sediment imbalance is more complicated than detecting an absolute concentration or percentage that represents a clear biological impact.

SWQB and USEPA Region 6 contracted with Tetra Tech, Inc., to develop sediment translators or thresholds. The contractor generally followed the steps provided in USEPA's Framework for developing suspended and bedded sediment water quality criteria (USEPA 2006). This effort included the identification of sediment characteristics that are expected under the range of environmental settings in New Mexico, especially in undisturbed or best available reference streams. Examining the relationships between biological measures and sediment indicators helped to identify where disturbance had caused sediment imbalance and biologically relevant habitat degradation. The analysis resulted in threshold recommendations for two bedded sediment indicators for New Mexico perennial streams (Table 7.1) – % Sand & Fines (%SaFN) and log Relative Bed Stability calculated without bedrock (LRBS_NOR) -- in three site classes, Mountains, Foothills, and Xeric. The site classes are defined by Level 3 and 4 ecoregions (Griffith et al. 2006) and distinguish sediment expectations across New Mexico. The report detailing this effort (Jessup et al. 2010) is available at http://www.nmenv.state.nm.us/SWQB/.

Table 7.1. Bedded sediment indicators (Jessup et al. 2010)

Sediment Indicator	Description
Percent Sand & Fines (%SaFN)	**The percentage of systematically selected streambed substrate particles that are ≤2.0 mm in diameter from reach-wide pebble count.**
Log Relative Bed Stability (LRBS)	**A measure of the relationship of the median particle size in a stream reach compared to the critical particle size calculated to be mobilized by standardized fluvial stresses in the reach.** Median particle size is determined using a reach-wide pebble count (Peck et al. 2006). Critical particle size is calculated from channel dimensions, flow characteristics, and channel roughness factors (Kaufmann et al. 2008). The measure is expressed as a logarithm of the ratio of geometric mean to critical particle size.
LRBS_NOR	**RBS without bedrock or hardpan (log10).** This measure regards only the potentially mobile streambed particles in determining the geometric mean particle size, and improved associations between the bedded sediment measure and biological responses in the TetraTech analyses (Jessup et al. 2010)

To determine if there is excessive sedimentation/siltation in the study stream reach, two levels of assessment are performed in sequential order. The first level considers the simpler indicator of biological impairment, and then refines the assessment with the second indicator of geomorphic impairment as needed when the first level threshold is exceeded. The % SaFN sediment indicator is used in the Level One assessment because it is easily measured and related strongly with biological metrics. If the %SaFN indicates excessive fine sediment in the stream bed, a Level Two survey is performed to calculate the LRBS_NOR value.

In minimally disturbed streams, the measured geometric mean particle size should trend towards the expected particle size (i.e., the size the stream is capable of moving as bedload at bankfull). The LRBS_NOR indicator considers site-specific hydraulic potential for moving bed sediments, so that the observed amount of fine sediments are considered impaired only when the streambed is more easily mobilized and transported than expected. It incorporates stream channel, shape, slope, flow, and sediment supply. The LRBS_NOR measure is appropriate as a second-tier indicator because it is scaled to hydro-geomorphic factors of the individual sites, as well as to the broader site classes, thus allowing evaluation of the potential of the specific site in terms of retaining or flushing fine sediments.

Table 7.2 Sedimentation indicator thresholds based on biological responses and reference distributions (Jessup et al. 2010)

Site Class	% Sand and Fines	LRBS_NOR Units
Mountain	< 20	> 1.1
Foothill	< 37	> 1.3
Xeric	< 74	> 2.5

If the calculated LRBS_NOR is greater than the applicable site class threshold in Table 7.2, the assessment unit is regarded as **Full Support** with respect to New Mexico's narrative sedimentation/siltation standard found at NMAC 20.6.4.13 (NMWQCC 2011). If the calculated LRBS_NOR is less than or equal to the applicable site class threshold, the assessment unit is considered **Non Support**.

7.1 Monitoring Results

During the 2011 survey, impairment of the narrative criterion for sedimentation in 20.6.4.13 NMAC was documented in the Rio Puerco above Cuba, due to exceedances of numeric sedimentation thresholds.

Geomorphic habitat data was collected for the Rio Puerco at Highway 550 bridge on September 8, 2011. The monitoring station is within Ecoregion 22n, which is assigned to the Xeric site class. The % Sand and Fines was 81.9, which is greater than the indicator threshold on Table 7.2, so additional data were collected to calculate the LRBS_NOR indicator. The calculated indicator was -2.76. Since the indicator was lower than the threshold on Table 7.2, the AU was assessed as impaired for sedimentation.

Table 7.3 Percent reduction for sand and fine sediment in the upper Rio Puerco

Assessment Unit	Target Load (%Sand&Fines)	Measured Load (%Sand&Fines)	Percent Reduction (%)
Rio Puerco (Perennial part northern boundary Cuba to headwaters)	74	81.9	9.6

A load-based indicator is needed in order to generate a TMDL based on mass balance. Jessup et al. 2010 suggests an interpretation of the indicator value distributions for sites which fully support their designated uses, using the 90th percentile value for Mountain and Foothills sites and the 75th percentile value for Xeric sites (Table 7.3). Excess sediment derives from the watershed and stream channel above the location where it has been deposited. It would be appropriate to use a weighted average target for this AU given that the watershed spans all three sedimentation classes. The Rio Puerco above Cuba AU is 62.1% within Mountains, 22.4% within Foothills, and 15.5% within the Xeric site class. Applying these proportions to the recommended indicators on Table 7.3 yields a TSS threshold of 18.38 mg/L.

Table 7.4. Suspended sediment indicator percentiles for fully supporting sites and all sites inthree site classes.

		Fully Supporting Sites			All Sites		
		Valid N	75th	90th	Valid	25th	Median
Mountains	Turbidity (NTU)	68	4.88	9.50	217	1.25	3.10
	TSS (mg/L)	70	5.05	8.75	221	3.00	3.89
FootHills	Turbidity (NTU)	24	12.18	19.30	136	2.33	5.99
	TSS (mg/L)	24	9.88	16.12	138	3.71	6.71
Xeric	Turbidity (NTU)	83	68.50	191.76	289	5.60	16.00
	TSS (mg/L)	85	60.23	262.80	295	7.00	17.00

Only two Total Suspended Solids (TSS) results are available for this AU from the 2011 survey. TSS was 18 mg/L on March 24, and 36 mg/L on May 13. The measured load will be considered the mean average of the results, 27 mg/L.

7.2 Flow

The sediment moving capacity of a stream is exponentially related to flow velocity and discharge. Therefore, most of the work of streams is accomplished during floods when stream velocity and discharge (and therefore capacity) are many times their level during low flow regimes. This work is in the form of bed scouring (erosion), sediment transport (bed and suspended loads), and sediment deposition. Therefore, for this parameter, the critical flow value used to calculate the TMDL was the median annual peak flow for the period of record.

Rio Puerco (Perennial part northern boundary Cuba to headwaters), is an ungaged AU. The nearest available data comes from USGS gage 08332525, an Automated Crest Stage Gage located on the Rio Puerco below Cuba. This type of gage records only the annual high flow event. Data was available for the period 1997 to 2014. The median peak flow for this time period was 449.5 cfs. The AU with the sedimentation impairment drains 8.7% of the watershed area above the USGS gage. Thus the critical high flow used for the TMDL is 8.7% of 449.5, which equals 39.1 cfs, or 25.27 MGD.

The TMDL itself is a value calculated at a defined critical condition as part of a planning process designed to achieve water quality standards. Since flows vary throughout the year in these systems, the actual load at any given time will vary based on the changing flow. Management of the load to improve stream water quality is the goal of SWQB efforts.

7.3 Loading Capacity

This section describes the relationship between the numeric target and the allowable pollutant load by determining the total assimilative capacity of a waterbody, or loading capacity, for sediment. The loading capacity is the maximum amount of pollutant that a waterbody can receive at a given flow while meeting its water quality objectives. This TMDL was developed based on simple dilution calculations using the critical high flow, the watershed weighted average criterion, and a unit conversion factor (Equation 7.2, Tables 7.5 and 7.6).

Equation 7.2

$$Critical\ Flow\ \times WQS \times Unit\ Conversion\ Factor = Target\ Loading\ Capacity\ (TMDL)$$

By applying Equation 7.2 to TSS, it is determined that the Rio Puerco above Cuba can transport approximately 3873.6 lbs/day of TSS during critical flow conditions during which instream concentrations should not exceed 18.38 mg/L.

Table 7.5 Target load for TSS in the upper Rio Puerco

Assessment Unit	Critical Flow (MGD)	TSS Indicator for Sedimentation Impairment (mg/L)	Unit Conversion Factor	TMDL[(a)] (lbs/day)
Rio Puerco (Perennial part northern boundary Cuba to headwaters)	25.27	18.38	8.34	3873.6

The measured load for TSS was calculated using data from the only two results available from the 2011 survey. In order to achieve comparability between the target and measured loads, the same flow value was used for both calculations. The collected data was substituted for the numeric target in Equation 7.2. The same unit conversion factor was utilized. The calculated measured load is shown in Table 7.6.

Table 7.6 Measured load for TSS in the upper Rio Puerco

Assessment Unit	Critical Flow (MGD)	Arithmetic Mean Concentration (mg/L)	Unit Conversion Factor	Measured Load (lbs/day)
Rio Puerco (Perennial part northern boundary Cuba to headwaters)	25.27	27	8.34	5690.3

The load reduction necessary to meet the target load was calculated to be the difference between the calculated Target Load (Table 7.5) and the measured load (Table 7.6), as shown in Table 7.7.

Table 7.7 Percent reduction for TSS to meet target load in the upper Rio Puerco

Assessment Unit	Target Load (lbs/day)	Measured Load (lbs/day)	Load Reduction (lbs/day)	Percent Reduction (%)
Rio Puerco (Perennial part northern boundary Cuba to headwaters)	3873.6	5690.3	1816.7	31.9

7.4 Margin of Safety and Allocations

7.4.1 Margin of Safety

TMDLs should reflect a MOS based on the uncertainty or variability in the data, the point and nonpoint source loading estimates, and the modeling analysis. The MOS can be expressed implicitly, explicitly, or a combination of the two. An implicit MOS is incorporated by making conservative assumptions in the TMDL analysis, such as allocating a conservative load to background sources. An explicit MOS is applied by reserving a portion of the TMDL and not allocating it to any other sources.

For the sedimentation TMDL presented in this document, there are no permitted point sources on the Assessment Unit, so there will be no MOS associated with point sources. The MOS for the TMDL was developed using a combination of conservative assumptions and allocating an explicit portion of the TMDL in recognition of potential errors. Therefore, this MOS is the sum of the following two elements:

- Conservative Assumptions:
  - TSS is a conservative parameter that does not settle out of the water column.

- Explicit Recognition of Potential Errors:
  - Uncertainty exists in the relationship between TSS and deposition of excess sediment. A conservative MOS for this element is **10%**.
  - There is error inherent in all flow measurements. A conservative MOX for this element in gaged streams is **5%**.

Total MOS for this TMDL is **15%**.

7.4.2 Waste Load Allocation

There are no individually permitted point source facilities or MS4 stormwater permits in this assessment unit. Sediment may be a component of some (primarily construction) stormwater discharges that contribute to suspended sediment impacts, and should be addressed.

In contrast to discharges from other industrial stormwater and individual process wastewater permitted facilities, stormwater discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the NPDES CGP requires preparation of a SWPPP that includes identification and control of all pollutants associated with the construction activities to minimize impacts to water quality. In addition, the current CGP also includes state-specific requirements to implement BMPs that are designed to prevent the maximum extent practicable, an increase in sediment or a parameter that addresses sediment (e.g., TSS, turbidity, siltation, stream bottom deposits, etc.), and flow velocity during and after construction compared to pre-construction conditions. In this case, compliance with a SWPPP that meets the requirements of the CGP is generally assumed to be consistent with this TMDL.

Other industrial stormwater facilities are generally covered under the current NPDES MSGP. This permit also requires the preparation of a SWPPP that includes identification and control of all pollutants associated with the industrial activities to minimize impacts to water quality. In addition, the current MSGP also includes state-specific requirements to further limit (or eliminate pollutant loading) to water quality impaired/water quality limited waters from facilities where there is a reasonable potential to contain pollutants for which the receiving water is impaired. In this case, compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL. It is not possible to calculate individual WLAs for facilities covered by the MSGP at this time using available tools. The discharges from the MSGP are typically transitory and enforcement is complex as permittees are temporary. Loads that are in compliance with the General Permits are therefore currently included as part of the LA. While these sources are not given individual allocations, they are addressed through other means, including BMPs, stormwater pollution prevention conditions, and other requirements.

7.4.3 Load Allocation

In order to calculate the LA for turbidity, the MOS was subtracted from the target load (TMDL) using the following Equation 7.4:

Equation 7.4

$$LA + MOS = TMDL$$

Or

$$LA = TMDL - MOS$$

The MOS was developed using a combination of conservative assumptions and explicit recognition of potential errors. The explicit MOS is estimated to be 15% of the target load calculated in Table 7.5. The TMDL was allocated per Equation 7.4 and the resulting allocations are listed in Tables 7.8.

Table 7.8 TMDL for Sedimentation in the Rio Puerco (Perennial part northern boundary Cuba to headwaters)

WLA (lbs/day)	LA (lbs/day)	MOS (15%) (lbs/day)	TMDL (lbs/day)
0	3292.6	581.0	3873.6

7.5 Identification and Description of Pollutant Sources

SWQB fieldwork includes an assessment of the probable sources of impairment. The approach for identifying probable sources of impairment includes additional input from a variety of stakeholders including landowners, watershed groups, and local, state, tribal, and federal agencies.Probable source sheets are filled out by SWQB staff during watershed surveys and watershed restoration activities. The draft probable source list was reviewed and modified as necessary with watershed group/stakeholder input during the TMDL public meeting and comment period. See a full description of the probable source documentation process, and the completed sheets for the upper Rio Puerco impaired AUs, in Appendix B.

Although this procedure includes subjective and qualitative elements, SWQB has concluded that it provides the best available information for the identification of probable sources of impairment in a watershed. The list of probable sources is not intended to single out any individual land owner or particular land management activity and generally includes several sources per impairment. Pollutant sources that may contribute to each segment were determined by field reconnaissance and evaluation (Table 7.9). Probable sources of sedimentation impairment will be evaluated, refined, and changed as necessary through the WBP.

Table 7.9 Probable source summary for sedimentation impairment – Rio Puerco (northern boundary Cuba to headwaters)

Probable Anthropogenic Sources	Probable Natural Sources
Irrigation return drains	
Dams/diversion	Waterfowl
Flow alteration from water diversions	Wildlife other than waterfowl
Highway/road/bridge runoff	
Stream channel incision	
On-site treatment systems	
Residences/buildings	
Pavement/impervious surfaces	
Rangeland grazing	
Livestock grazing/feeding operation	
Low water crossing	
Bridges/culverts/RR crossing	
Logging – active harvesting	
Logging – legacy	
Paved roads	
Gravel or dirt roads	
Crop production (dry land)	

7.6 Linkage between Water Quality and Pollutant Sources

Although natural rates of sediment input vary among and within regions, human activities can alter these inputs. Excessive watershed erosion from these activities can transport large amounts of fine sediments into streams, leading to frequent bed mobility and poor instream habitat. Conversely, some human alterations like dredging, channelization or upstream impoundments, may lead to a lack of fine sediments in some parts of the channel, but an excess in other places. Clearing vegetation from banks and riparian areas may increase siltation and reduce large woody debris in streams. Logging or farming up to the stream banks, building roads across or along streams, dredging and straightening the stream channel, and building dams or other diversion structures in the stream channel may destabilize stream banks and change bottom substrate size and composition. Even in streams draining “pristine” watersheds that are at equilibrium between sediment supply and transport, one might expect different characteristic values of [Relative Bed

Stability] that are dependent upon the "natural" rates of erosion. In the absence of human activities, these natural erosion rates would depend upon climate, basin geology, geomorphology, channel position within the watershed, and related features such as glaciers and natural landslide frequency (Kaufman et al, 2008).

The headwaters of Nacimiento and La Jara Creeks occur on land managed by the Santa Fe National Forest. The Forest recently adopted a Travel Management Plan (Record of Decision issued in 2012), to regulate the routes open or closed to various types of motorized vehicle use. Forestwide, it reduces the total acres available to drive and camp by 19 percent, acres on soils with an erosion hazard rating of moderate or severe by 18 percent, acres within 300 feet of all streams by 29 percent, and acres within 300 feet of impaired streams by 45 percent. The Plan also eliminates any legal motorized travel within 100 feet of perennial water. Roads, culverts and crossings with no traffic will continue to contribute excess sediment and storm flow to water bodies. The Forest Service estimates that natural recovery would take in excess of 15 years. Some routes, in order to completely return to natural condition, would require the Forest Service to physically decommission them. Closing them to motorized use is the first step, and it is likely that the forest will decommission some routes within the next 15 years.

7.7 Consideration of Seasonal Variation

For years in which the date of peak flow at the gage is known, the majority of peak flows occurred during the "monsoon" thunderstorm season of July – September. In years when peak flow occurred outside of the monsoon season, the peak discharge tended to be lower than average.

7.8 Future Growth

Growth estimates by county are available from the New Mexico Bureau of Business and Economic Research. These estimates project growth to the year 2040. Sandoval County population is projected to increase in population by 72% over the 2015-2040 period, from 154,048 to 265,607 (UNM, 2012). The city of Rio Rancho is likely to be the major contributor to this projected growth. Rio Rancho is approximately 71 miles distant from Cuba, the population center nearest the La Jara Creek, Nacimiento Creek and upper Rio Puerco assessment units.

The estimate of future growth in Sandoval County may lead to a significant increase in stream water aluminum if additional residences are developed in the watersheds of Nacimiento and La Jara Creeks, or if additional recreational pressure is brought to bear within the Santa Fe National Forest. BMPs should continue to be utilized to avoid, minimize, and mitigate land disturbance, improve roads and low water crossings, and adhere to SWPPP requirements related to construction and industrial activities covered under the general permit. Any future growth would be considered part of the existing load allocation, assuming persistence of the hydrologic conditions used to develop these TMDLs.

8.0 MONITORING PLAN

Pursuant to CWA §106(e)(1), 33 U.S.C. §1251 (Clean Water Act, 2002), the SWQB has established appropriate monitoring methods, systems, and procedures in order to compile and analyze data on the quality of the surface waters of New Mexico. In accordance with the New Mexico Water Quality Act, §74-6-1 et seq. (NMSA, 1978), the SWQB has developed and implemented a comprehensive water quality monitoring strategy for the surface waters of the State.

The monitoring strategy establishes the methods of identifying and prioritizing water quality data needs, specifies procedures for acquiring and managing water quality data, and describes how these data are used to progress toward three basic monitoring objectives: to develop water quality-based controls, to evaluate the effectiveness of such controls, and to conduct water quality assessments.

The SWQB was actively involved in national conversations with USEPA and the Association of Clean Water Administrators (ACWA) regarding the new Long Term Vision for the Clean Water Act Section 303(d) program. The goals of the Long Term Vision are prioritization of watershed or waters for restoration and protection; assessment of priority waters; protection of unimpaired waters; alternative approaches to restoration and protection; engagement with the stakeholders; and integration with other CWA programs. As a result, the monitoring and TMDL programs in New Mexico are being revised to allow a greater focus on state water quality priorities, encourage TMDL alternatives, and emphasize the value of protecting waterbodies that are not impaired. A Prioritization Framework summarizes the realignment of monitoring and TMDL activities in New Mexico. The list of monitoring and TMDL priorities through 2020 was determined using the process outlined in the Framework and is available on the SWQB TMDL website.

The SWQB utilizes a rotating basin system approach to water quality monitoring. In this system, select watersheds are intensively monitored for two years with an established return frequency of approximately every eight years. The next scheduled monitoring years for the Rio Puerco watershed are 2019-2020. The SWQB maintains current quality assurance and quality control plans to cover all monitoring activities. This document, called the QAPP, is updated and certified annually by USEPA Region 6 (NMED/SWQB, 2013a). In addition, the SWQB identifies the data quality objectives required to provide information of sufficient quality to meet the established goals of the program. Current priorities for monitoring in the SWQB are driven by the CWA §303(d) List of streams requiring TMDLs.

Once assessment monitoring is completed, those reaches showing impacts and requiring a TMDL will be targeted for more intensive monitoring. The methods of data acquisition include fixed-station monitoring, intensive surveys of priority assessment units (including biological assessments), and compliance monitoring of industrial, federal, and municipal dischargers, as specified in the SWQB Standard Operating Procedures (NMED/SWQB, 2013). Long-term monitoring for assessments will be accomplished through the establishment of sampling sites that are representative of the waterbody and which can be revisited approximately every seven years. This information will provide time relevant information for use in CWA §303(d) listing and 305(b) report assessments and to support the need for developing TMDLs. The approach provides:

- A systematic, detailed review of water quality data which allows for a more efficient use of valuable monitoring resources;
- Information at a scale where implementation of corrective activities is feasible;

- An established order of rotation and predictable sampling in each basin which allows for enhanced coordinated efforts with other programs; and
- Program efficiency and improvements in the foundations for management decisions.

Outside of years of intensive survey, the rotating basin program will be supplemented with other data collection efforts such as on-going studies being performed by the USGS, USEPA, and other programs within NMED. Data will be analyzed and field studies will be conducted to further characterize acknowledged problems, and TMDLs will be developed and implemented accordingly. Both long-term and intensive field studies can contribute to the State's Integrated §303(d)/ §305(b) listing process for waters requiring TMDLs.

9.0 IMPLEMENTATION OF TMDLS

9.1 Point Sources – NPDES Permitting

There are no existing point sources with an individual NPDES permit that have potential impacts to the waters addressed in this TMDL report.

9.2 Nonpoint Sources – Watershed Based Plan and Best Management Practice Coordination

Public awareness and involvement will be crucial to the successful implementation of these plans and improved water quality. A WBP is a written plan intended to provide a long-range vision for various activities and management of resources in a watershed. It includes opportunities for private landowners and public agencies in reducing and preventing nonpoint source impacts to water quality. This long-range strategy will become instrumental in coordinating efforts to achieve water quality standards in the watershed. The WBP is essentially the Implementation Plan, or Phase Two of the TMDL process. The completion of the TMDLs and WBP leads directly to the development of on-the-ground projects to address surface water impairments in the watershed.

A Watershed Restoration Action Strategy (predecessor to the current WBP format) was completed for the Rio Puerco watershed in 2001 (available online at: https://www.env.nm.gov/swqb/documents/swqbdocs/WPS/WRAS/RioPuercoWRAS-May2001.pdf). The WRAS has not been updated, and therefore the watershed is currently not eligible for Clean Water Act implementation funding. If necessary, updated planning documents should be drafted to meet the requirements and include identified impairments and the new TMDLs. SWQB staff will provide technical assistance such as selection and application of BMPs needed to meet WBP goals. Stakeholder public outreach and involvement in the implementation of this TMDL will be ongoing. Stakeholders in this process are likely to include the Rio Puerco Management Committee, Rio Puerco Alliance, the Cuba Soil and Water Conservation District, private landowners, USFS, and other interested parties.

9.3 Clean Water Act §319(h) Funding

The Watershed Protection Section of the SWQB can potentially provide USEPA §319(h) funding to assist in implementation of BMPs to address water quality problems on reaches listed as Category 4 or 5 waters on the CWA §303(d) List. These monies are available to all private, for-profit, and non-profit organizations that are authenticated legal entities, or governmental jurisdictions including: cities, counties, tribal entities, Federal agencies, or agencies of the State. Proposals are submitted by applicants through a Request for Proposal ("RFP") process. Selected projects require a non-federal match of 40% of the total project cost consisting of funds and/or in-kind services. Funding is potentially available, generally annually, for both watershed-based planning and on-the-ground projects to improve surface water quality and associated habitat. Further information on funding from the CWA Section 319(h) can be found at the SWQB website: http://www.nmenv.state.nm.us/swqb/.

9.4 Other Funding Opportunities and Restoration Efforts

Several other sources of funding exist to address impairments discussed in this TMDL document. NMED's Construction Programs Bureau assists communities in need of funding for WWTP upgrades and improvements to septic tank configurations. They can also provide matching funds for appropriate CWA Section 319(h) projects using state revolving fund monies. The USDA Environmental Quality Incentive Program ("EQIP") program can provide assistance to private land owners in the basin. The USFS, a major land owner in the watersheds discussed in this document, aligns their mission to protect the lands that they manage with the TMDL process and are another source of assistance. The BLM has several programs in place to provide assistance to improve unpaved roads and grazing allotments.

The New Mexico Legislature appropriated $2.3 million in state funds for the River Stewardship Program during the 2014 Legislative Session and $1 million during the 2015 Special Session. The River Stewardship Program has the overall goal of addressing the root causes of poor water quality and stream habitat. Objectives of the River Stewardship Program include: “restoring or maintaining hydrology of streams and rivers to better handle overbank flows and thus reduce flooding downstream; enhancing economic benefits of healthy river systems such as improved opportunities to hunt, fish, float or view wildlife; and providing state matching funds required for federal CWA grants.” A competitive request for proposals was conducted for 2014 funding and twelve projects located throughout the state were selected. Responsibility for the program is assigned to NMED, and SWQB staff administers the projects. SWQB expects to issue a request for proposals for the 2015 funding in early 2016.

10.0 APPLICABLE REGULATIONS AND STAKEHOLDER ASSURANCES

New Mexico's Water Quality Act ("Act") authorizes the WQCC to "promulgate and publish regulations to prevent or abate water pollution in the state" (NMSA 1978, § 74-6-4 (E)) and to require permits. The Act authorizes a constituent agency to take enforcement action against any person who violates a water quality standard. Several statutory provisions on nuisance law could also be applied to NPS water pollution. The Water Quality Act also provides that:

> "[t]he Water Quality Act does not grant to the commission or to any other entity the power to take away or modify the property rights in water, nor is it the intention of the Water Quality Act to take away or modify such rights."

NMSA 1978, §74-6-12 (A). In addition, the State of New Mexico Surface Water Quality Standards, Subsection C of 20.6.4.4 NMAC also provides:

> "C. Pursuant to Subsection A of Section 74-6-12 NMSA 1978, this part does not grant to the water quality control commission or to any other entity the power to take away or modify property rights in water."

20.6.4.4 (C) NMAC. New Mexico policies are in general accord with the federal Clean Water Act Section 101 (g), 33 U.S.C. §1251 (g), goals:

> "It is the policy of Congress that the authority of each State to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this chapter. It is the further policy of Congress that nothing in this chapter shall be construed to supersede or abrogate rights to quantities of water which have been established by any State. Federal agencies shall co-operate with State and local agencies to develop comprehensive solutions to prevent, reduce and eliminate pollution in concert with programs for managing water resources."

33 U.S.C. §1251 (g). New Mexico's CWA Section 319 program has been developed in a coordinated manner with the State's 303(d) process. All Section 319 watersheds that are targeted in the annual RFP process coincides with the State's preparation of the biennial impaired waters listing as approved by the USEPA. The State has given a high priority for funding, assessment, and restoration activities to these impaired/listed watersheds.

As a constituent agency, NMED has the authority pursuant to NMSA 1978, Section 74-6-10, to issue a compliance order or commence civil action in district court for appropriate relief if NMED determines that actions of a "person" (as defined in the Act) have resulted in a violation of a water quality standard including a violation caused by a NPS. The NMED NPS water quality management program has historically strived for and will continue to promote voluntary compliance to NPS water pollution concerns by utilizing a voluntary, cooperative approach. The State provides technical support and grant monies for implementation of BMPs and other NPS prevention mechanisms through Section 319 of the Clean Water Act (33 U.S.C. § 1329). Since portions of this TMDL will be implemented through NPS control mechanisms, the New Mexico Watershed Protection Program will target efforts to this and other watersheds with TMDLs.

In order to obtain reasonable assurances for implementation in watersheds with multiple landowners, including federal, state, and private entities, NMED has established Memoranda of Understanding ("MOU") with various federal agencies, in particular the USFS and the BLM. A MOU has also been developed with other state agencies, such as the New Mexico Department of Transportation. These MOUs provide for coordination and consistency in dealing with NPS issues.

The time required to attain standards for all reaches is estimated to be approximately ten to twenty years. This estimate is based on a five-year time frame implementing several watershed projects that may not be starting immediately or may be in response to earlier projects. Stakeholders in this process will include the SWQB, and other parties identified in the WBP. The cooperation of watershed stakeholders will be pivotal in the implementation of these TMDLs as well.

11.0 PUBLIC PARTICIPATION

Public participation was solicited in development of this TMDL. The draft Upper Rio Puerco TMDL was first made available for a 30-day comment period beginning January 20, 2016 and ending on February 19, 2016. The draft document notice of availability was extensively advertised via email distribution lists, webpage postings, and press releases to area newspapers. A public meeting was held on February 4, 2016 at the Cibola County Courthouse in the Town of Grants. One written comment was received during the public comment period (see Appendix C).

The TMDL was presented for WQCC approval on April 12, 2016. Upon approval by USEPA Region 6, the next step for public participation is development of a WBP, as described in Section 11.2, and participation in watershed protection projects including those that may be funded by Clean Water Act §319(h) grants. The WBP development process is open to any member of the public who wants to participate.

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APPENDIX A

SPECIAL STATUS SPECIES KNOWN TO OCCUR IN RIPARIAN AND AQUATIC HABITATS IN SANDOVAL COUNTY

Common Name	Scientific Name	Status	Habitat
Crawford's Desert Shrew	*Notiosorex crawfordi*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Western Water Shrew	*Sorex navigator*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Pale Townsend's Big-eared Bat	*Corynorhinus townsendii*	State NM: Sensitive taxa (informal) USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Fringed Myotis	*Myotis thysanodes*	State NM: Sensitive taxa (informal)	RIPARIAN
Long-legged Myotis	*Myotis volans*	State NM: Sensitive taxa (informal)	RIPARIAN
Western Small-footed Myotis	*Myotis ciliolabrum*	State NM: Sensitive taxa (informal)	RIPARIAN
Spotted Bat	*Euderma maculatum*	State NM: Threatened USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Big Free-tailed Bat	*Nyctinomops macrotis*	State NM: Sensitive taxa (informal)	RIPARIAN
American Marten	*Martes americana*	State NM: Threatened USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Ringtail	*Bassariscus astutus*	State NM: Sensitive taxa (informal) USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Botta's Pocket Gopher	*Thomomys bottae actuosus; alienus; aureus; collis; connectens; cultellus; fulvus; guadalupensis; lachuguilla; mearnsi; morulus; opulentus; paguatae; pectoralis; peramplus; pervagus; planorum; rufidulus; ruidosae; tol*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Meadow Jumping Mouse	*Zapus hudsonius luteus*	Federal: Endangered State NM: Endangered USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Long-tailed Vole	*Microtus longicaudus longicaudus; alticola; baileyi; mordax*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Brown Pelican	*Pelecanus occidentalis*	State NM: Endangered USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Snowy Egret	*Egretta thula*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN

Common Name	Scientific Name	Status	Habitat
White-faced Ibis	*Plegadis chihi*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Common Black Hawk	*Buteogallus anthracinus*	State NM: Threatened USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Bald Eagle	*Haliaeetus leucocephalus*	State NM: Threatened USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Northern Goshawk	*Accipiter gentilis*	State NM: Sensitive taxa (informal) USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Ferruginous Hawk	*Buteo regalis*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Swainson's Hawk	*Buteo swainsoni*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Zone-tailed Hawk	*Buteo albonotatus*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Mississippi Kite	*Ictinia mississippiensis*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Peregrine Falcon	*Falco peregrinus*	State NM: Threatened USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Arctic Peregrine Falcon	*Falco peregrinus tundrius*	State NM: Threatened USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Osprey	*Pandion haliaetus*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Sora	*Porzana carolina*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Snowy Plover	*Charadrius nivosus*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Long-billed Curlew	*Numenius americanus*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Neotropic Cormorant	*Phalacrocorax brasilianus*	State NM: Threatened USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Yellow-billed Cuckoo (western pop)	*Coccyzus americanus occidentalis*	Federal: Threatened State NM: Sensitive taxa (informal) USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Burrowing Owl	*Athene cunicularia*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Flammulated Owl	*Psiloscops flammeolus*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN

Common Name	Scientific Name	Status	Habitat
Mexican Spotted Owl	*Strix occidentalis lucida*	Federal: Threatened State NM: Sensitive taxa (informal) USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Black Swift	*Cypseloides niger*	State NM: Sensitive taxa (informal)	RIPARIAN
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	Federal: Endangered State NM: Endangered USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Loggerhead Shrike	*Lanius ludovicianus*	State NM: Sensitive taxa (informal) USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Gray Catbird	*Dumetella carolinensis*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
American Redstart	*Setophaga ruticilla*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Belted Kingfisher	*Megaceryle alcyon*	USFS Sensitive: Region 3 (NM,AZ)	RIPARIAN
Northern Leopard Frog	*Lithobates pipiens*	USFS Sensitive: Region 3 (NM,AZ)	AQUATIC RIPARIAN SEMI-AQUATIC
Rio Grande Chub	*Gila pandora*	State NM: Sensitive taxa (informal) USFS Sensitive: Region 3 (NM,AZ)	AQUATIC FULLY AQUATIC
Rio Grande Silvery Minnow	*Hybognathus amarus*	Federal: Endangered State NM: Endangered USFS Sensitive: Region 3 (NM,AZ)	AQUATIC FULLY AQUATIC
Rio Grande Sucker	*Catostomus plebeius*	USFS Sensitive: Region 3 (NM,AZ)	AQUATIC FULLY AQUATIC
Rio Grande Cutthroat Trout	*Oncorhynchus clarkii virginalis*	State NM: Sensitive taxa (informal) USFS Sensitive: Region 3 (NM,AZ)	AQUATIC FULLY AQUATIC
Wrinkled Marshsnail	*Stagnicola caperata*	State NM: Endangered USFS Sensitive: Region 3 (NM,AZ)	AQUATIC FULLY AQUATIC
Paper Pondshell	*Utterbackia imbecillis*	State NM: Endangered	AQUATIC FULLY AQUATIC

APPENDIX B

PROBABLE SOURCE DOCUMENTATION

"Sources" are defined as activities that may contribute pollutants or stressors to a water body (USEPA 1997). The list of "Probable Sources of Impairment" in the Integrated 303(d)/305(b) List, Total Maximum Daily Load documents (TMDLs), and WBPs is intended to include any and all activities that could be contributing to the identified cause of impairment. Data on Probable Sources is routinely gathered by Monitoring and Assessment Section staff and Watershed Protection Section staff during water quality surveys and watershed restoration projects and is housed in the Assessment Database ("ADB") (ADB version 2). ADB was developed by USEPA to help states manage information on surface water impairment and to generate §303(d)/ §305(b) reports and statistics. More specific information on Probable Sources of Impairment is provided in individual watershed planning documents (e.g., TMDLs, WBPs, etc.) as they are prepared to address individual impairments by assessment unit.

USEPA through guidance documents strongly encourages states to include a list of Probable Sources for each listed impairment. According to the 1998 305(b) report guidance, "…, states must always provide aggregate source category totals…" in the biennial submittal that fulfills CWA section 305(b)(1)(C) through (E) (USEPA 1997). The list of "Probable Sources" is not intended to single out any particular land owner or single land management activity and has therefore been labeled "Probable" and generally includes several sources for each known impairment.

The approach for identifying "Probable Sources of Impairment" was recently modified by SWQB. Any new impairment listing will be assigned a Probable Source of "Source Unknown." Probable Source Sheets will continue to be filled out during watershed surveys and watershed restoration activities by SWQB staff. Information gathered from the Probable Source Sheets will be used to generate a draft Probable Source list in consequent TMDL planning documents. These draft Probable Source lists will be finalized with watershed group/stakeholder input during the pre-survey public meeting, TMDL public meeting, WBP development, and various public comment periods. The final Probable Source list in the approved TMDL will be used to update the subsequent Integrated List.

Literature Cited:

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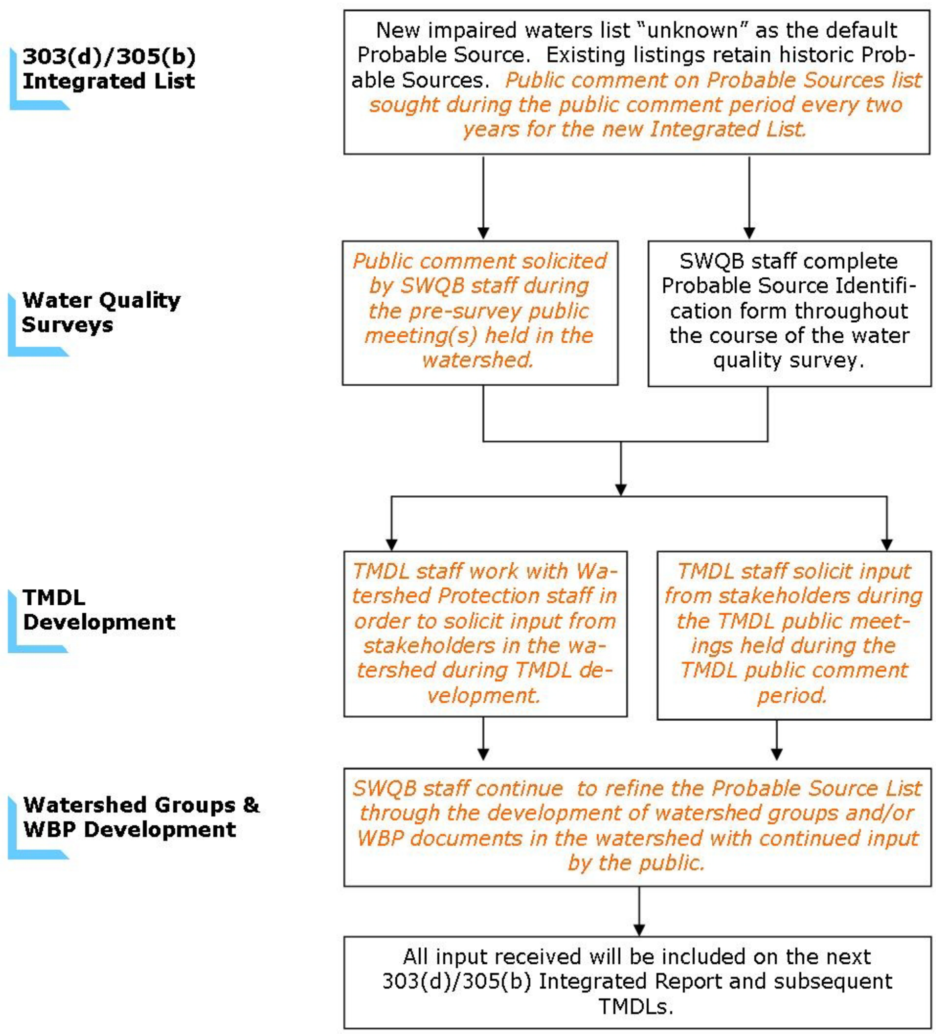
Probable Source Development Process



New Mexico Environment Department
Surface Water Quality Bureau

Figure B1. Probable Source Development Process and Public Participation Flowchart

Help Us Identify Probable Sources of Impairment

Name:
Phone Number (optional):
Email or Mailing Address (optional):
Date:
Waterbody or site description (example - Fish Creek near HWY 34 crossing):

From the list below, please check activities known to exist that you are concerned may be contributing to surface water quality impairment. Please score items you check based on distance to or occurrence on or near the waterbody of concern.

(1 = Low occurrence or not near waterbody)
(3 = Moderate occurrence or within ½ mile of waterbody)
(5 = High occurrence or right next to water body)

✓	ACTIVITY	Score			✓	ACTIVITY	Score		
☐	Feedlots	1	3	5	☐	Pavement and Other Impervious Surfaces	1	3	5
☐	Livestock Grazing	1	3	5	☐	Roads/Bridges/Culverts	1	3	5
☐	Agriculture	1	3	5	☐	Habitat Modification(s)	1	3	5
☐	Flow Alterations (water withdrawal)	1	3	5	☐	Mining/Resource Extraction	1	3	5
☐	Stream/River Modification(s)	1	3	5	☐	Logging/Forestry Operations	1	3	5
☐	Storm Water Runoff	1	3	5	☐	Housing or Land Development	1	3	5
☐	Drought Related	1	3	5	☐	Habitat Modification	1	3	5
☐	Landfill(s)	1	3	5	☐	Waterfowl	1	3	5
☐	Industry/Wastewater Treatment Plant	1	3	5	☐	Wildlife other than Waterfowl	1	3	5
☐	Inappropriate Waste Disposal	1	3	5	☐	Recreational Use	1	3	5
☐	Improperly maintained Septic Systems	1	3	5	☐	Natural Sources	1	3	5
☐	Waste from Pets	1	3	5	☐	Other: *(please describe)*	1	3	5

Comments/additional information:

Revised 02Aug12

APPENDIX C

PUBLIC COMMENT

SWQB hosted a public meeting in Grants, New Mexico on February 4, 2016 to discuss the Public Comment Draft Upper Rio Puerco TMDL. Notes from the public meeting are available in the SWQB TMDL files in Santa Fe. A public meeting scheduled for Cuba, New Mexico on February 2, 2016 was cancelled due to inclement weather.

SWQB received the following public comments on the Draft Upper Rio Puerco TMDLs:

A. James P. Morgan, Springer, New Mexico

Changes made to the report based on public and internal staff comment include:

a. Minor editorial corrections were made throughout the document.
b. Section 11 (Public Participation) was updated.
c. No changes were made to the document in response to public comment

16 February 2016

TMDL and Assessment Team
SWQB
P.O. Box 5469
Santa Fe, NM 87502

ATTN: Heidi Henderson

Team Members:

I would like to offer some comments regarding the proposed TMDLs for the UPPER RIO PUERCO WATERSHED with respect to aluminum.

1. A major concern would be the use of a total recoverable analysis for the determination of a TMDL for Al.

It is indicated in the USEPA Water Quality Standards Handbook, Section 3.6, Policy On Aquatic Life Criteria for Metals, that a dissolved analysis is preferred over a total recovery method, but that a total recovery analysis is allowable. However, as stated in 3.6.3., "Both the TMDL and NPDES uses of water quality analysis require the ability to translate between dissolved metal and total recoverable metal." This is because the dissolved fraction is considered to be the causative factor of toxicity.

As there has been no conversion factor established to make that translation for Al, it would seem problematic to base a TMDL for Al solely on a total recovery analysis. And any attempt to develop such a conversion factor would have to be pH specific, as the character and relative content of Al containing species in the water column is very pH dependent. Multiple positively charged Al species exist at acidic conditions; whereas, only a single negatively charged ion, the aluminate ion, $Al(OH)_4^{-1}$, is present at basic conditions, in equilibrium with the neutral solid gibbsite, $Al(OH)_3^0$. See discussions in the papers of (Gensemer and Playle, 1999) and (Hem, J. D. and C.E. Roberson, 1967) referenced in the proposed TMDL.

Unfortunately, the NM hardness-based Al standard, currently in place, does not require a calculated distribution of Al containing species at the pH of the water sample collected. Or even a determination of the dissolved Al content.

SWQB response:
Thank you for your comments. The aluminum TMDLs in the 2016 Rio Puerco TMDL document are based on an assessment of the water quality data collected during the SWQB Rio Puerco/Zuni water quality survey in 2011. Data collected at both La Jara Creek and Naciemiento Creek did not meet the total recoverable aluminum water quality standard as described in the State of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC) and the 2013 Assessment Protocols. The impairment listings for total recoverable aluminum were approved by the New Mexico Water Quality Control Commission on September 9, 2014 and by USEPA Region 6 on November 18, 2014. Many of your comments are not related specifically to

the TMDL but rather apply to the aluminum water quality standards in the State of New Mexico Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC). SWQB has included responses below consistent with those expressed in the 2013 Triennial Review of Standards for Interstate and Intrastate Surface Waters.

USEPA's water quality handbook and policy for metals is fitting for most metals which are toxic in the dissolved form. Two exceptions are Aluminum (Al) and Selenium (Se) which are suspected of having toxic effects in the colloidal or solid form (Al particles retained by a 0.45µm nominal pore size filter). In tests with the brook trout at low pH and hardness, effects increased with increasing concentrations of total aluminum even though the concentration of dissolved aluminum was constant, indicating that total recoverable is more appropriate measurement than dissolved, at least when particulate aluminum is primarily aluminum hydroxide particles (USEPA, 2002). Total recoverable Al is defined in the State of New Mexico Water Quality Standards for Interstate and Intrastate Surface Waters (20.6.4 NMAC) as that analyzed in an unfiltered sample or which is filtered to remove inert mineral forms of Al common to New Mexico's geology. Whether filtered or not, the SWQB protocol for sample handling captures the entire dissolved Al fraction plus the colloidal fractions (~0.45 to 1.0 µm) implicated in harming aquatic life (Gensemer and Playle, 1999). Hence, a translator to convert from a solid Al analysis to a dissolved fraction is unnecessary and would lead to an underprotective standard that fails to account for solid-phase toxic Al.

2. The current NM hardness-based standard for Al is restricted to dissolved hardness concentrations between 25 and 220 mg/L. So, the measured Al concentrations at hardness levels of 21.11 and 16.54 for La Jara Creek cannot be assessed using the hardness-dependent formulations, as the hardness levels are less than 25 mg/L. Presumably, the restriction to not less than 25 mg/L hardness is because the calculated allowable Al levels become much less than any observed concentration effect levels for Al.

At the highest hardness levels usable for the formulations, up to 220 mg/L, the calculated acute criterion is 10,070 ug/L Al, total Al, which far exceeds the solubility of Al in the pH range allowed in NM surface waters. Such a large value could not represent the amount of aluminate ion present. Even at pH 9.0 the concentration of the Al content of the ion would only be 5,400 ug/L. See the discussion below. The pH of 6.98 obtained in La Jara Creek might be an anomaly, as ambient surface waters in NM tend to be somewhat basic due to the buffering provide by the alkalinity contents. If the measurement was accurate a consideration of positively charged Al containing species would be appropriate.

***SWQB response*:**
20.6.4.900.I NMAC states: "For aluminum the equations are valid only for dissolved hardness concentrations of 0-220 mg/L. For dissolved hardness concentrations above 220 mg/L, the aluminum criteria for 220 mg/L apply." Thus, surface waters are assessed for Al under all hardness levels. In the table of selected criteria found in 20.6.4.900 NMAC, 25 mg/L is presented as the minimum dissolved hardness; however this table represents examples of selected criteria and is not all inclusive. The equations are used to calculate Al criteria for all hardness values between 0-220 mg/L.

As mentioned in the response to Comment 1, New Mexico's criteria for aluminum were designed to account for both soluble and insoluble forms of aluminum implicated in toxicity to aquatic life

(Gensemer & Playle, 1999). Moreover, USEPA's recommended national water quality criteria document recommends Al criteria expressed as total or acid soluble fractions (USEPA, 1988). Accordingly, New Mexico's water quality standards express Al criteria to protect aquatic life as "total recoverable." Since the chronic aquatic life use for this stream is impaired based on results for total recoverable Al, it is the total recoverable criterion that was used in the TMDL to establish water quality goals.

3. The measured aluminum concentration of samples taken from Nacimiento Creek, passed through a 10 micrometer-pore capsule filter at pH's ranging from 7.6 to 8.5, were from 150 to 3000 ug.

Such Al content would be composed of dissolved Al species and suspended Al containing solids. The dissolved Al species at the stated pH's would be the aluminate ion, whose concentration would be determined by the equilibrium $Al(OH)_{3(c)}+H_2O=Al(OH)_4^{-1}+H^+$, as expressed by the hydrolysis constant expression $K=[H^+][Al(OH)_4^{-1}]$, $K=2.0X10^{-13}$,(Hem and Roberson, 1967). The suspended solid would be gibbsite, $Al(OH)_3^0$, inert at the pH range considered.

The Al concentration values obtained from the Nacimiento Creek samples would be in fair agreement with calculated dissolved concentrations of Al in the aluminate: 170 ug/L at pH 7.5, 560 ug/L at pH 8.0 and 1950 ug/L at pH 8.5.

<u>SWQB response:</u>

The State of New Mexico Al standards are for total recoverable Al, which may be filtered to remove some but not all solid phase Al. At higher pH (>8) an increasing fraction of the total may be in the form of the soluble aluminate ion [$Al(OH)_4^{-1}$], however recent studies of equilibrated dissolved Al at pH>8, ostensibly aluminate ion, showed no toxicity (Poleo and Hytterod, 2003), and that maximum Al toxic accumulation on fish gills occurred at pH 6 to 8 (Winter et al, 2005) .

4. It would be important to know the alkalinity of the creeks in order to calculate the buffering capabilities during spring runoff periods when there might be ingress of acidic waters.

<u>SWQB response:</u>

Currently, New Mexico's aquatic life protection criteria are assessed within a range of pH (pH 6.6 to 9.0) conducive to aquatic life, particularly salmonids, but water pH is not taken into account in the hardness-dependent equations, nor is the acid neutralizing capacity of streams. SWQB will carefully consider the forthcoming EPA guidance for Al, which may take multiple water quality parameters into consideration. However, as stated in the Department's rebuttal testimony for the 2013 Triennial Review of Standards for Interstate and Intrastate Surface Waters, recent USEPA updates indicate that after water hardness is taken into account, pH relayed no additional information regarding aluminum toxicity to salmonids (Eignor, 2013).

5. These comments largely relate to criticisms of: the current total recovery method of analysis of Al content, and the hardness-based formulation used to calculate allowable Al content for toxicity determination purposes. It is acknowledged that this is how things must be done at present. Should there be changes in methodology and the Al content standard, it would be prudent to reconsider the results obtained for the Rio Puerco.

Regards,
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SWQB response:

SWQB periodically reviews water quality standards, sampling methodologies and assessment protocols based on new information and USEPA guidance. If any meaningful changes occur, SWQB will update impairment listings and/or TMDLs as appropriate.

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